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H. R. Blakeslee

An Old Mill Wheel

(*See letter on page 321 concerning this picture*)

MECHANICAL ENGINEERING

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1939

GEORGE A. STETSON, *Editor*

The Gas Turbine

EVER SINCE men have turned their attention to converting the heat energy in fuel into work, they have been fascinated by two attractive possibilities, the rotative engine and the engine that makes the conversion without the intermediary equipment of the steam boiler. Antecedents of the rotative engine are ancient, but it was not until relatively recently that the steam turbine was developed to take the place of the reciprocating engine, principally in the generation of electrical energy in large amounts. The rotary engine has been less successful, although an amazing number of ingenious mechanisms have been devised by an extraordinary number of men who have followed this approach to the problem of producing rotative motion.

Of the problem of eliminating the steam boiler, the internal-combustion engine has provided the most successful solution and is today the type of prime mover best known among laymen, largely through its use in automotive vehicles and because it can be operated with a minimum of effort and intelligence. The air engine represented a short-lived attempt to develop a prime mover without the use of a steam boiler. Today it is all but forgotten.

To devise a machine that would operate on the rotative principle of the turbine and at the same time dispense with the steam boiler by expanding the products of combustion of fuel was a natural development and one that many inventors have sought to promote in spite of inherent difficulties that the problem presents. Today, however, with the availability of metals that will withstand working temperatures in excess of 900 F and with the development of efficient compressors of the turbine type, the gas turbine is a commercial reality.

Such a machine was described in a paper read by Adolph Meyer, director, Brown Boveri and Company, Ltd., of Baden, Switzerland, at a meeting in London on Feb. 24, 1939, of The Institution of Mechanical Engineers. The operation of the combustion gas turbine as Dr. Meyer calls it is essentially simple. Into a combustion chamber where gaseous, liquid, or pulverized fuel is burned is introduced air for combustion and cooling that has been compressed in a turbocompressor. The products of combustion and the excess air pass on to a gas turbine where they are expanded in the performance of useful work. Turbine, compressor, and an electric generator are mounted on a common shaft, and the power in excess of that needed for the compressor drives the generator. According to Dr. Meyer, the efficiency corresponding to a temperature of 1000 F at the inlet of the turbine, referred to output at the coupling and the net calorific value of the fuel and an assumed over-all compressor and turbine efficiency of 73 to 75 per cent, easily obtainable with net outputs of 2000 to 8000 kw, can be expected to reach 17 to 18 per cent. Increased efficiency may be obtained by preheating the air supplied to the compressor by means of the turbine exhaust in a heat exchanger and, further, by dividing the turbine into two or more stages and reheating to 1000 F between stages. Thus, with 1000 F inlet temperature and a preheating heat exchanger of 5000 sq ft, the efficiency of a 2000-kw unit would be raised from 16.5 to 21 per cent. A unit of this size and with 1000 F inlet temperature and with one stage of reheating to the initial temperature will have an efficiency of 19 per cent without a preheater and of $22\frac{1}{2}$ per cent with a 5000-sq ft preheater.

Many interesting applications of the gas turbine were mentioned by Dr. Meyer. In this country, at the Marcus Hook plant of the Sun Oil Company, a gas-turbine supercharging unit is used in connection with the Houdry cracking process, which demands hot compressed air. This apparatus has been in operation for two years, and success with it has resulted in orders for 10 other units, of which one is in operation in Texas and another in Italy. A 400-kw generating set ordered by the City of Neuchatel for installation in a bomb-proof powerhouse is an example of one kind of stand-by service for which the gas turbine is suggested. For locomotive use comparisons with steam power show greater efficiency with less weight and length, and while the efficiency is not as low as that of Diesel power, an advantage is claimed in the use of fuel oil rather than more expensive Diesel fuel. Marine installations, with advantages of less weight and space and absence of boilers, wind-tunnel drives, and blast-furnace applications are proposed by Dr. Meyer.

As to the future, improvements rest with the possibility of using higher temperatures. For example, a two-cylinder gas turbine of 2000 kw capacity, with intermediate reheating, shows an efficiency of 24 per cent without air preheating, 26.5 per cent with a 5000-sq ft preheater, and 33 per cent when the preheater surface is increased to 30,000 sq ft.

The interesting combination of the rotative engine and the direct expansion of products of combustion is another example of the dynamic and evolutionary character of engineering design. With developments in collateral fields, such, for example, as metallurgy in this case, impracticable ideas of engineers of former generations become practicable, and new "unorthodox" machines find their places. Nor is the end of this process in sight. Electricity direct from coal has always tempted inven-

tors. Why interpose the complicated machinery and energy-conversion steps, each exacting its toll of waste, each contributing to capital, operating, and maintenance expense? Research on the problem is under way. Engineers, viewing a richly productive past, should be the last to say it can't be done, even if they are keenly conscious of the difficulties.

Youth and Labor

AN INTERESTING example of enterprising journalism that will cause many an editor to kick himself for not having pulled it off is to be found in the March issue of *Occupations—The Vocational Guidance Magazine*, the official organ of the National Vocational Guidance Association, published by the National Occupational Conference. It is a symposium, "Youth and Labor," consisting of five articles written by five men who have, or have had, definite labor affiliations.

In the first two articles William Green and John L. Lewis attempt to answer the question, Why should youth join with organized labor? In the third John J. Collins, former chairman of an independent union and at present an instructor at Fordham University, puts the case for the independent union. Leo Wolman, professor of economics at Columbia University, writer on labor problems, sometime research chief for the Amalgamated Clothing Workers of America, former chairman of the Labor Advisory Board, NRA, and former chairman of the Automobile Labor Board that antedated the NLRB, writes under the title "A Candid Look at Organized Labor." The fifth article is contributed by George B. Cutten, president of Colgate University, who "started life as a skilled workman's helper, since which time he has maintained a deep interest in labor problems."

What Messrs. Green and Lewis have to say is what you would expect men to say who have something to sell. The other three contributors offer comments on union leadership that are pitched in a rising crescendo of criticism.

Among the positive and negative reasons motivating the organization of independent unions Mr. Collins suggests some of the criticisms commonly leveled against the A.F.ofL. and C.I.O. Mr. Wolman states the two major policies of labor unions, "democratizing the relations in industry between employers and employees" and "securing for their members superior economic conditions," which he characterizes as a "simple and obviously praiseworthy program which on its face would appear to commend itself to all sensible persons." He then analyzes the reasons for the relatively small number of union members, traces the effect of the new labor laws, gives an example of opposition to organization, questions the economic gains claimed by organized labor, wonders why labor in this country has not profited by experiments in foreign countries, and ends by saying that "the price of this policy (i.e., neglecting experiment abroad) is a large and standing army of unemployed, supported by huge and continuing public deficits, and kept out of jobs they otherwise might have had."

The concluding article is the most outspoken, and the virile philosophy upon which it is based is applicable not only to unions and labor leaders but to all of us—industrialists, professional people, businessmen, college presidents, and editors. "I believe in labor unions," says President Cutten, who, many years ago, carried a dinner pail as a gas piper's helper, "believe in them much more than labor leaders do. I believe in them enough to demand that they should be incorporated, accept responsibility for their actions, and account for their funds . . . . . Labor unions should no longer be kept under the stigma of irresponsibility."

He then goes back to the fundamental principle of competition, "one of nature's rules of progress." "Unlimited competition within one's own group, and the joining of the competitors to fight other groups," he says "have been the rules by which civilization has advanced. Whenever competition has failed within the group, then degeneration has set in. There is no reason to think that this law has changed."

"The labor unions," he continues, "have consistently broken this great law of progress. The unions have insisted upon the elimination of competition and the rewarding of the inefficient and incompetent."

"America was to our fathers, as it was to the world, the land of opportunity," he next points out. "A young man was to receive the rewards of industry, intelligence, and personality, without any restraint. He was in competition with all, but there were no favors and the best man won . . . . . These days are past. Does a young man want to work at a trade of his own choosing, he must ask the labor unions; does he choose an industrial task and wish to work in peace and safety, he must join a labor union; does he wish to use his strength and intelligence and industry so as to attain for himself the greatest rewards, he is reminded of labor-union wages and stints. Herding is for the protection of the weak, not for the advantage of the strong . . . . . Nature has her own union composed of the fittest and the best and in which only he has a right to a job who has initiative to secure it, ability to fill it, and perseverance and tenacity to hold it . . . . ."

Strong and harsh words, perhaps, but the fundamental truth that underlies them applies to us all. Nor should the closing paragraph of President Cutten's contribution be ignored.

"It is usually believed that competition is nature's only law—the law of the jungle. That is far from true. Cooperation is as much a natural law as competition, but nature is very careful to have these laws properly placed. Labor unions have not followed this rule. To cooperate for protection of incompetent workmen at the expense of the competent, and to compete with management so as to close down one's own factory to the advantage of a competitive factory is as inappropriate and unreasonable as wearing a raincoat during the sunshine, and a straw hat in the rain. Raincoats and straw hats are both valuable but only when used at an appropriate time. Let us refine natural laws as much as we please, but when we ignore or confuse them, nature is bound to take her revenge."

AMERICA LOOKS TO HER GUNS

By MAJOR-GENERAL C. M. WESSON

CHIEF OF ORDNANCE, U. S. ARMY

IT IS A great honor to be invited to address this gathering of members of your renowned engineering organizations, The American Society of Mechanical Engineers and the Louisiana Engineering Society.

The engineer is seldom given proper credit for his accomplishments. We are inclined to take for granted the thousand and one conveniences and luxuries which surround us, and which he has made possible by his indefatigable industry and perseverance. Reward does not come to him in the form of popular acclaim. Nor does he seek it. His greatest recompense is derived from the satisfaction of creating those things which prove to be useful to mankind in the pursuit of happiness.

There is another class of implements in the production of which we must rely on the genius and brains of the engineer. I refer not to those things which add to our comfort and convenience, but to those tools and instruments designed for the defense of human life and of the institutions which have been laboriously erected by the hand and brain of man in the onward march of civilization.

It falls to my lot as Chief of Ordnance of the U. S. Army to be concerned with these implements of defense. This occasion affords me the opportunity to acknowledge publicly the cooperation and assistance rendered by engineers to the Ordnance Department of the Army in its engineering activities. I am also happy to announce that at this very moment plans are under way—plans which have been sponsored by the national secretary of the A.S.M.E., Colonel C. E. Davies—which will definitely increase the contribution of this Society in the important field of preparedness.

WHY AMERICA SHOULD LOOK TO HER GUNS

Today, civilization is standing at the crossroads. Forces are rampant in the world which, if unchecked, may set us back a thousand years. The liberty which mankind fought for and achieved will disappear. The individual will become a pawn in a society constructed on the basis of might and opposed to justice, one in which every act of the individual is controlled and directed by a dictator's will.

There is reason aplenty why America should look to her guns. Let us take stock of the situation and see where we stand. To envisage our present situation with respect to preparedness, a brief review of the outstanding events which have taken place, both here and abroad, during the past twenty-five years in their relation to this all-important question would seem to be in order.

Twenty-two years ago we were drawn into the Great War under conditions which demanded our maximum effort. We were totally unprepared for this war and, except for certain factors in our favor at the time, it might have ended quite differently.

8-IN. RAILWAY GUN

The armies of our allies were able to hold at bay the ground forces of our enemy. The fleets of our allies were able to bottle up the fleets of our enemy. Sea communications were not closed to us, and the problem of our Navy in escorting and protecting the troop and supply ships was thereby greatly simplified. Only the occasional submarine that succeeded in reaching the high seas had to be guarded against. The equipment and munitions with which we finally engaged the enemy were supplied very largely by our allies.

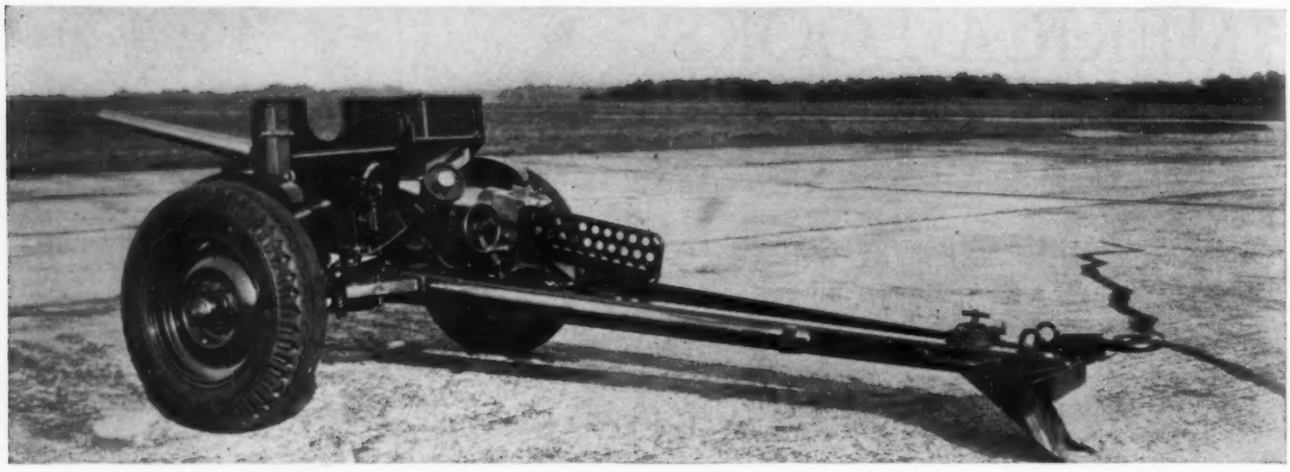
By Nov. 11, 1918, Armistice Day, the entire nation was functioning in high gear in support of the armies in the field. Industries, after much stumbling and delay, most of which was not chargeable to them but to the War Department, were producing munitions at an unprecedented rate. We had four million men under arms, and we had eventually what was perhaps the finest and best equipped army the world has ever seen. We were veritably a nation in arms—and so ended the War to End Wars. Or did it?

After the war came the inevitable reaction. Also came the Disarmament Conference. We scrapped a large part of what would have been the greatest navy ever possessed by any country. Appropriations for the Army were cut to the bone. There was little money for development and practically none for new material. There was a tremendous feeling of security. Our storehouses were full of guns and ammunition. Friendly oceans separated us from possible enemies. The Treaty of Versailles presumably had hamstrung our former enemies.

The League of Nations was set up and supported by all the victor nations, except ourselves. It initiated a policy which it was hoped would lead to general disarmament throughout the world.

While this period of lethargy for a time generally prevailed

An address delivered at a joint session with the Louisiana Engineering Society at the National Spring Meeting, New Orleans, La., Feb. 23–25, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.



37-MM ANTITANK GUN—TRAVELING POSITION

throughout the world, it was more pronounced in this country than in the other great powers, except perhaps in England where disarmament was actually carried out by substantial reductions in the air, naval, and land forces of that nation.

Research and development continued, however, quite generally in the larger European countries, and new and improved types of both offensive and defensive equipment were produced. But, so long as there was no general rearmament, there was no concern, because we were all more or less growing obsolescent together.

A few years ago, however, this picture was radically changed. Germany, it will be recalled, under the Treaty of Versailles, was very definitely restricted as to armament, both qualitatively and quantitatively. She was permitted no bombing planes or tanks or guns of large caliber, only a limited number of machine guns, rifles, and small-caliber artillery sufficient for a force of 100,000 men.

In France, England, and Italy much attention was devoted to improvement and modernization of existing types, and much energy expended thereon.

But, in Germany no such problem existed. She *had* no equipment. So, when she threw off the shackles of Versailles, the way was cleared for her to equip herself with arms and munitions of the very latest and most efficient types. This she proceeded to do with a vengeance. Six years ago she was relatively impotent. Today, if one can believe all one hears, she is a knight in shining armor ready and eager to demonstrate her power.

Italy, her allied state, delights in boasting of her vaunted strength and that she can put into the field on short notice ten million men equipped with the most efficient types of weapons.

England and France are now busily engaged in modernizing certain types of existing weapons and have launched large programs for new types of equipment. They are making a desperate effort to catch up with the running start they allowed Germany and Italy.

UNITED STATES TODAY IS UNPREPARED FOR WAR

Now, as regards equipment for our ground forces, where do *we* stand? Notwithstanding the fact that appropriations were increased a few years ago, so as to provide for some new armament, the fact remains that today our first-line troops—that is, the Regular Army and the National Guard, a force of only 400,000 men—are short of new and improved types of equipment and the necessary ammunition reserves of a value well over one hundred million dollars, embracing items, many of which in the ordinary course of events, will take two years to produce.

Mind you, I am not speaking of a national army of a million, two million, or three million men, but of that small spearhead of any national force we may raise, a force of only 400,000 men—our very first-line troops, our Regular Army, and our National Guard. It is to remedy this situation that the item of $110,000,000 appears in the program recently sent to Congress by the President.

VALUE OF AIRPLANE AS MILITARY WEAPON

But what of the air? The improvement made in fighting aircraft since the World War greatly exceeds the corresponding improvement made in either land or naval armament. Speed and duration of flight have been multiplied many times. Guns mounted in aircraft are not only more numerous but more powerful. Bomb-carrying capacity has increased from a few hundred pounds to tons.

So the airplane has assumed a place of power. We may justifiably conclude, perhaps, that the airplane at Munich won a peace, or at least a temporary peace, but it has yet to be demonstrated whether the airplane, per se, can win a war.

Madrid and Barcelona were bombed repeatedly. The morale of the population was not destroyed, and the people of these cities proceeded about their customary pursuits after each raid. Casualties, while serious, were relatively small in proportion to the total population. No appreciable number of ships has been destroyed by bombs either in China or Spain, and yet there has been ample opportunity. It is said that in Spain six hundred attacks against unarmed and defenseless merchant vessels have resulted in the sinking of relatively few of them. Against ships provided with aircraft defense, the number would, no doubt, have been much less, and bombing planes could not have in all cases flown off unscathed.

The value of the military airplane as an auxiliary weapon is enormous. It is absolutely necessary in modern war for reconnaissance, attack, pursuit, and for bombing. It is, however, essentially an offensive weapon. By that is meant that it may take but cannot hold. It must operate from bases held and protected by other troops. Barcelona fell only when it came within the range of Franco's artillery.

The history of war clearly demonstrates that victory was not complete until the critical objectives were in the complete and proud possession of the infantry soldier, to whom all other arms of the service—artillery, tanks, cavalry, as well as aircraft—are auxiliary.

The observations I have just made seem to me to be appropriate in connection with the consideration of national defense in general. I am tempted to dwell upon them, but I must not lose

sight of the fact that my specific message to you tonight concerns the Ordnance Department of the Army, its duties, its responsibilities, and some of its many problems and how we strive to solve them.

DUTIES, RESPONSIBILITIES OF ORDNANCE DEPARTMENT

To appreciate where the Ordnance Department fits into our scheme for national defense, let us consider briefly, if you please, the national defense policy of the United States.

It is clearly the intent of Congress and the people that we should have a powerful navy, equal at least to that possessed by any other nation. The National Defense Act, adopted in 1920, provides for a small Regular Army to defend our foreign possessions, man our coast defenses, and supply a nucleus for organizing and training a much enlarged army in the event of war.

This act also provides that the Regular Army be backed up by a well-trained National Guard. It also provides for the Organized Reserves to come to the support of the permanent military establishment in the event of war. These three elements constitute the Army of the United States.

It is believed to be the policy of the country that the Regular Army and the National Guard be armed and equipped with matériel equal or superior to that possessed by any other nation, and the immediate objective of the government at this time is to modernize the arms and equipment of the Regular Army and the National Guard.

These two organizations, taken together and recruited to war strength, are known as the Initial Protective Force. This force numbers about 400,000 men. Since it should be ready to take the field on very short notice, it is essential that it be at all times equipped with the latest types of arms and munitions.

The National Defense Act also envisages a carefully worked out plan for mobilizing both the man power and industrial resources of the nation, which plans would be called into operation only in the event of a major emergency.

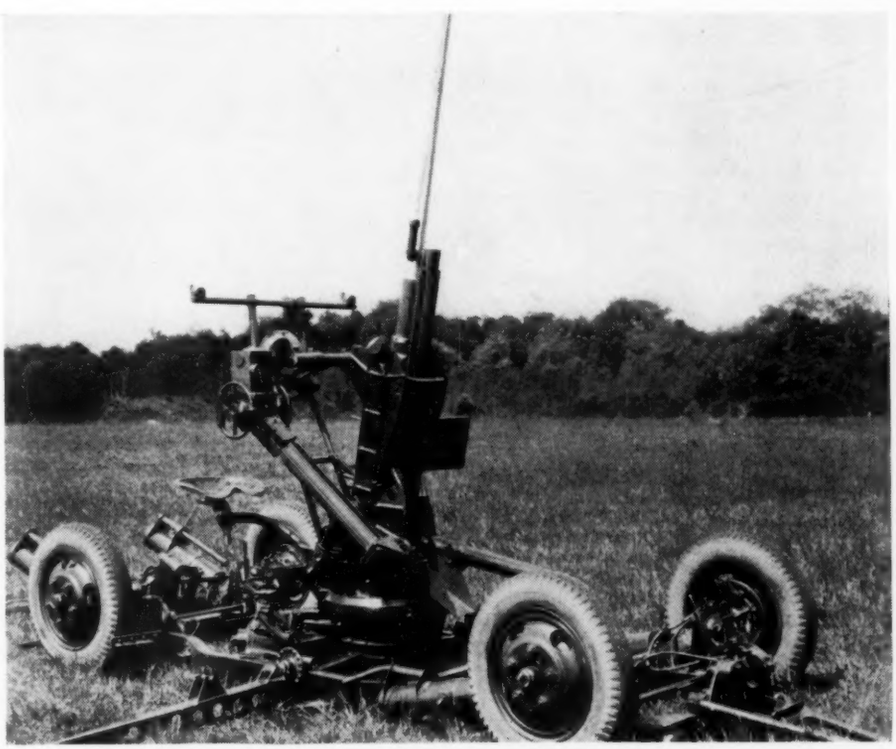
As regards the organization for national defense, there are two departments, the Army and the Navy, each headed by a civilian secretary and both under the President as commander in chief. The activities of the two departments are coordinated by various joint boards and cooperating agencies to insure coordination of effort and to prevent duplication and waste.

The War Department is the agency for coordinating and directing the activities of the various arms and services of the Army. The arms are the combatant branches, the artillery, cavalry, infantry, and air corps. The services, as their name implies, provide the needed supplies. The War Department, therefore, is concerned with both military and industrial problems. Under the Secretary of War, the Chief of Staff directs the military activities and the Assistant Secretary of War the industrial responsibilities. The general staff plans for the military effort and the planning branch of the Assistant Secretary of War plans for the industrial effort.

With the foregoing brief outline of national policy and organization to carry it out, I will now take up specifically the Army Ordnance Department. Its responsibility is to supply the men who bear arms with practically every offensive and defensive weapon needed by them, in the amounts and at the times required. This responsibility, broken down into its elements, includes design, development, procurement, storage, issue, and maintenance of matériel for the successful prosecution of war.

VAST NUMBER OF NONCOMMERCIAL ITEMS REQUIRED BY ORDNANCE DEPARTMENT

The diversity of the ordnance problem and its technical aspects are indicated by the fact that there are over 1200 separate items together with some 250,000 components in the general categories of cannon and their mounts, rifles, pistols and machine guns, fire-control instruments, tanks, combat cars and scout cars, bombs and pyrotechnics, and all types of small-arms and artillery ammunition. These items are noncommercial and embody in their design the application of every phase of



37-MM ANTIAIRCRAFT GUN—FIRING POSITION COMPLETED

science and, in the main, can be designed successfully only by specially trained engineers—men who are not easily obtainable, since industry does not produce comparable matériel.

The magnitude of the operations of the department in peace and in war is indicated by the appropriations made to the department from year to year. The appropriations ran from ten to twelve million dollars per year prior to the World War, increasing somewhat just before our entrance into that conflict. They were tremendously increased during the war years, amounting to over four billion dollars for the fiscal year starting July 1, 1918. From this, you can readily see the enormous expansion of ordnance activities in time of war.

The ordnance problem logically resolves itself into two major components, *provision* and *distribution*.

Provision includes:

(1) Research, design, development
(2) Procurement, either by purchase or manufacture
(3) Procurement planning.

Distribution includes:

(1) Storage and issue
(2) Maintenance, both in the hands of troops and in storage.

RESEARCH AND DEVELOPMENT COVER WIDE FIELD

Research and development are responsibilities of the first magnitude. If we were in that fortunate position where the types of our equipment were the best of every kind in the world and were likely to remain so for an indefinite time, there would be little need for research leading to the development of the new and improved designs. Unfortunately, this is not the case. As technology advances, science is continually developing new types of combat equipment and effecting improvements in existing types. The Ordnance Department must be alert as regards engineering and scientific developments which, though not primarily military in character, may be used in producing more efficient fighting equipment.

Not only this, but there are certain research activities which must be carried on directly by the Ordnance Department because industry itself conducts no research along these lines. In this category comes the science of ballistics, both interior and exterior, which in itself is an extremely broad field involving shapes of projectiles, rifling in guns, composition of powder, shape of powder chambers, methods of ignition, method of banding projectiles, shape and size of powder grains, all types of fuses and bombs, and other items too numerous to mention. In this category also come the complicated problems of fire control. In the automotive field come the problems of tracks and track suspensions for high-speed track-laying vehicles, special transmissions for handling powerful motors, and the cooling of engines under adverse conditions.

Since ordnance equipment is essentially special and has no counterpart in commerce and since the great bulk of military supplies required in war must be produced by private industry, it is necessary that designs, so far as possible, be susceptible of quantity production by commercial manufacturing methods. Every effort, therefore, is made to incorporate in these designs articles of commercial manufacture wherever it is possible to do so.

In order to meet the foregoing conditions, we must of necessity keep ourselves informed of three things:

(1) Scientific developments which may have military application.

(2) Types of military equipment developed by foreign nations.

(3) Commercial developments which may be applied to ordnance designs.

It is in the field of research and development that engineering organizations can be most helpful.

PROCUREMENT INVOLVES GOVERNMENT ARSENALS AND INDUSTRY

Now taking up procurement of ordnance material, this involves two functions—manufacture in government arsenals and procurement from industry. The manufacturing arsenals of the Ordnance Department where these manufacturing activities are carried out are Watertown, Mass. (established 1816), Springfield, Mass. (1795), Watervliet, N. Y. (1813), Picatinny, N. J. (1880), Frankford, Pa. (1815), and Rock Island Arsenal, Ill. (1863).

These arsenals are important elements in the operations of the department. In time of peace, they assist in the development of new designs and the improvement of existing matériel. We depend on them for production, at least in sufficient amounts to uncover production difficulties, standardize methods of manufacture, and determine costs.

It is mainly through the arsenals that the art of manufacture of ordnance is kept alive. They provide centers for the training of personnel in both peace and war, and provide a nucleus of trained personnel to assist in the inauguration of mass production. They should serve as a model for the particular items which they manufacture.

During the early months of war, before commercial facilities can begin production, they are our main source of manufacture of matériel required for the supply of the troops mobilized.

In order that the arsenals may perform these important functions, it is essential that they be given sufficient manufacturing orders each year to maintain them on a reasonable operating basis. Also their equipment should be of the latest types.

DESIRABLE THAT INDUSTRY BE GIVEN OPPORTUNITY TO MANUFACTURE NONCOMMERCIAL ITEMS

It is highly desirable that private industry be given an opportunity to manufacture noncommercial items of ordnance. Not only does this enable it to gain a much desired experience in the production of these items, but it also serves to prove whether or not our designs are susceptible of quantity production by industry in time of war. For this reason, orders for finished items of ordnance are placed with commercial manufacturers each year to the extent practicable within the funds appropriated and in conformity with the laws governing competition. These orders are normally placed through the arsenal responsible for the manufacture of the type of matériel to be purchased.

The orders that we have been able to place with industry for completed items are unfortunately few in number. Most of the orders are for components or semifinished parts. In time of a war of major effort 90 per cent of our requirements will have to be produced by firms, most of which must change over their production setup to fabricate the item assigned them and develop the necessary production technique. To improve this difficult situation, the so-called "educational order" has been evolved. During the current year Congress has authorized the expenditure by the War Department of $2,000,000 of War Department appropriations for this purpose. Under this authorization, bids for the manufacture of a few critical items of ordnance have been solicited from a selected list of prospective manufacturers. These bids are now being analyzed, and awards will soon be announced. The War Department has recommended the expenditure next year of $32,000,000 for the purpose.

The volume of ordnance which must be supplied by industry in a major war is so great that its procurement must be decentralized to the fullest extent possible. That was clearly demonstrated during the World War. The term "procurement" covers the negotiation of contracts, placing of orders, administration of these contracts, inspection of the finished material, and payment therefor. In order that this work may proceed promptly and efficiently, it is necessary that procuring agencies

be located conveniently to all the principal industrial production centers of the country.

FOURTEEN PROCUREMENT DISTRICTS ESTABLISHED

We, therefore, have established fourteen procurement districts in conformity with the procurement policies and plans of the Assistant Secretary of War. In time of peace, these districts function as procurement-planning agencies, and in time of war, as procurement agencies. Recently, we have assigned a large amount of inspection work to these districts and have had to increase their officer and civilian personnel.

The chief and assistant chief of each district are well-known industrialists familiar with the production facilities of plants in their respective districts. An officer of the Ordnance Department fills the position of executive officer.

The work which has been done by these districts is of transcending importance to national defense. All facilities in the district which have been allocated for ordnance production have been surveyed by them to determine which are best fitted to manufacture items apportioned to the district for war production. Production analyses then have to be made to determine the extent of plant conversion which will be necessary and the type and number of additional machine tools and other processing equipment which will be required.

In this work, industry has rendered great cooperation; and, while no formal contracts have been entered into for the 575 essential items designated for plant procurement, accepted schedules of production have been made for each one of them.

Now, gentlemen, we are a great nation. We possess the greatest industrial resources of any nation in the world. We possess the most intelligent man-power. We are, therefore, potentially the greatest military power. Yet, all of the wars in which we have been engaged have found us unprepared. Unpreparedness has cost us much blood and untold sums of money. Reasonable national defense is the best insurance against war. An America prepared to defend herself and her interests, both at home and abroad, is a stabilizing influence in world affairs. I believe it to be the duty of every American to combat at every turn those insidious influences which tend to weaken the morale of the nation. A people who have lost the will to fight and fail to provide themselves with the means of defense become the tempting prey of resolute and unprincipled nations.

ENGINEERS A VITAL FACTOR IN NATIONAL DEFENSE

As for the Army of the United States, it ranks eighteenth in size among the armies of the world. Its very smallness is the most convincing evidence that to be effective it and the National Guard should be equipped always with the best type of implements of war. They constitute a small protective force for that larger and greater army that will have to be mobilized and equipped in event of great emergency. This equipment cannot be quickly produced. It is noncommercial and highly technical. Therefore, plans for war-time production, while vital, are not sufficient. There also must be provided adequate reserves of material sufficient to meet the essential needs of our troops until such time as they may be produced by industry.

In all that I have discussed, the engineer must play a rôle of highest importance. It is to him that we must look for continued improvement in our matériel. We are placing our trust in him, and I know he will not fail us. Engineers, I salute you as a vital factor in our national defense!

75-MM HOWITZER IN ACTION

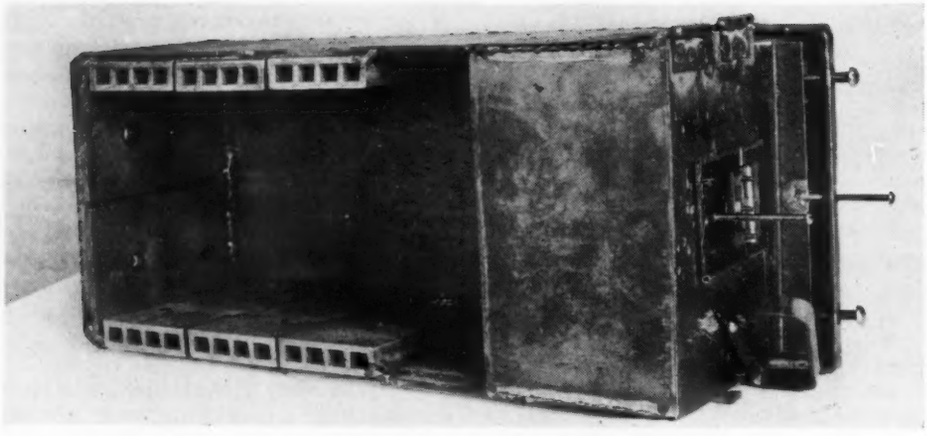


FIG. 1 FELLOWS DOWNDRAFT CONVERSION BURNER FOR A SMALL WARM-AIR FURNACE

A Downdraft CONVERSION BURNER *for* DOMESTIC FURNACES

By JULIAN R. FELLOWS

UNIVERSITY OF ILLINOIS, URBANA, ILL.

HAND-FIRED domestic furnaces, boilers, and stoves are responsible for a large part of the smoke which imperils health, damages property, and creates a dreary, dingy atmosphere in thousands of large cities and small towns throughout the bituminous-coal regions of the country. Since in these regions, bituminous coal, hand-fired, provides heat at less cost than other fuels, the development of a way to burn it smokelessly is a more feasible solution of the smoke problem than regulations against its use.

Use of various types of industrial stokers, including small underfeed domestic types, has proved that bituminous coal in the raw state may be burned without producing objectionable quantities of smoke. It therefore follows that a hand-fired plant may be operated smokelessly if the conditions in it are made similar to those in a stoker-equipped plant. These conditions are: (1) a slow rate of distillation of the smoke-producing gases, (2) the introduction into the combustion chamber of sufficient air to completely burn the gases to carbon dioxide and water vapor, and (3) the thorough mixing of the air and gases in a region where the temperature is sufficiently high to start the chemical action between the oxygen of the air and the hydrocarbon molecules of the gases.

At first it would seem impossible to produce these conditions in the hand-fired domestic plant which requires the placement at one time of several hours' supply of coal in the combustion chamber and the admittance of air over the fuel bed through openings in the firing door, and in which the temperature of all the surfaces usually stays far below the ignition temperature of the gases evolved.

An analysis of the problem discloses the fact that the incandescent coke bed is the only region where the temperatures are consistently high enough to ignite the volatile gases distilled from the coal. Therefore, any device or method for burning bituminous coal smokelessly must cause the gases, after being mixed with sufficient air, to pass through or in the proximity of this region. The results of tests with downdraft baffles, conducted several years ago at a firing school in St. Louis, Missouri,[1] suggested to the author the possibility of developing a downdraft conversion burner for hand-fired furnaces, boilers, and stoves.

During the last three years, thirty-five different models have been built in an effort to develop a simple device for burning bituminous coal efficiently and smokelessly. The author has used a downdraft conversion burner in his own home during the last three heating seasons, and in his community ten burner installations have been in operation in as many private homes since the autumn of 1937. The type of burner now being used is shown in Fig. 1. The view shown was taken with the burner lying on its side. It consists of a double-wall box with about two thirds of the bottom omitted and is installed with the open portion down. The burner is installed through the conventional firing-door opening without making any changes in the furnace and may be put in place without extinguishing the fire. It is supported in place by fitting that portion which has a closed bottom to the firing neck of the furnace, as shown in Fig. 2.

The part which is subjected to the most intense heat is formed of special heat-resisting metal and the other portions are designed to minimize warping. A door, located in the end of the burner, replaces the conventional firing door. The amount of secondary air which passes around the fuel and enters the combustion chamber through the air passages in the walls is regulated by an adjustable opening located above the firing door. The primary air which passes down through the fuel in the burner is regulated by the small draft damper fastened

Contributed by the Fuels Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and presented at the Semi-Annual Meeting of the Society in St. Louis, Mo., June 20–23, 1938.

[1] "Smokeless and Efficient Firing of Domestic Furnaces," by Victor J. Azbe, Trans. A.S.M.E., vol. 50, 1928, paper FSP-50-23, pp. 175–183.

to the front of the main door. This simple addition or attachment to the conventional furnace provides for all of the conditions necessary for the smokeless combustion of bituminous coal. While several hours' supply of coal may be added at one time, as in ordinary hand firing, the coal is placed so that the charge is heated slowly and the volatile matter in the new charge is driven off slowly. A sufficient amount of air for complete combustion of the gases is supplied through the secondary air passages formed by the double walls of the burner which permits the air to be introduced and mixed with the gases in the region directly over the incandescent coke bed.

The scale drawing in Fig. 2 shows the burner installed in a warm-air furnace in the author's home and represents a freshly

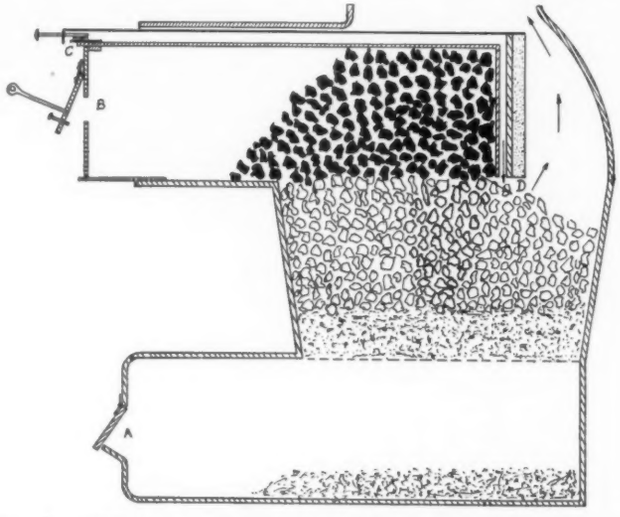


FIG. 2 SECTIONAL VIEW OF A FELLOWS BURNER PLACED IN A WARM-AIR FURNACE

charged condition, with the coke from the previous charge poked down to a level even with the lower edge of the burner walls. The greater part of the coke is burned in a manner similar to that in any conventional hand-fired furnace, with the air for combustion entering through the ashpit door at *A*. Since the hot gases do not pass through the green coal, the charge is heated only by the conduction of heat from the coke bed on which it rests. This results in very slow heating of the green coal, with an accompanying slow, steady evolution of volatile material throughout the coking period. Primary air entering at *B* passes down through the green coal in the burner and combines with the incandescent fixed carbon in the coke layer just below the coking region. Immediately after firing, the coking region is near the bottom of the burner, but it gradually works up through the charge of green coal until it reaches the top of the charge. The combustion in this coke layer raises the temperature in the region next to the green coal and increases the rate of evolution of gas from it. This rate can be controlled by regulating the air admitted at *B*. When the coking process is complete the coke which fills the burner may be poked down or it may be left in the burner until most of it has been burned with the aid of the primary air.

The secondary air which enters at *C*, directly above the firing door passes between the upper and lower roof sheets and to the lower edge of the burner through the passages provided by the double walls. Both the secondary air and the volatile gases pass under the lower edges of the burner and thoroughly mix at *D* where, under normal operating conditions, the temperature is sufficiently high to start the combustion process.

The best results are obtained when the fire is controlled by operating the ashpit damper together with the chimney check damper. The adjusting screw on the primary-air door at *B* may be set to provide a gas flame hot enough to carry the heating load during the coking process, which usually extends over a period of at least four hours. The bed of coke, which does not burn appreciably during this period, is then available for producing heat as needed for some time after the gas fire has burned out. The fire is very responsive to the controls and uniform temperatures may be attained with suitable thermostatic regulation. The curve in the upper part of Fig. 3 shows the flue-gas temperature for three hours after firing the burner. It may be noted that when the thermostat closed the ashpit air damper, the combustion rate quickly decreased to a low fixed rate determined by the amount of primary air entering through the opening in the firing door. The size of this opening is regulated by means of a screw adjustment.

The curves in the upper part of Fig. 4 show the temperature in the author's home with thermostatic regulation of the dampers. It may be noted that the temperature did not vary more than two degrees from the thermostat setting. Without thermostatic operation of the dampers there is some danger of overheating. The coke, which fills the combustion chamber below the level of the burner, offers little resistance to the flow of air and burns very rapidly when the air entering at *A* is not restricted.

A method which is better suited to hand manipulation of the dampers consists in operating the check damper in the chimney and the primary-air door at *B* while maintaining the same fixed opening at *C* and a very small fixed opening at *A*. While the

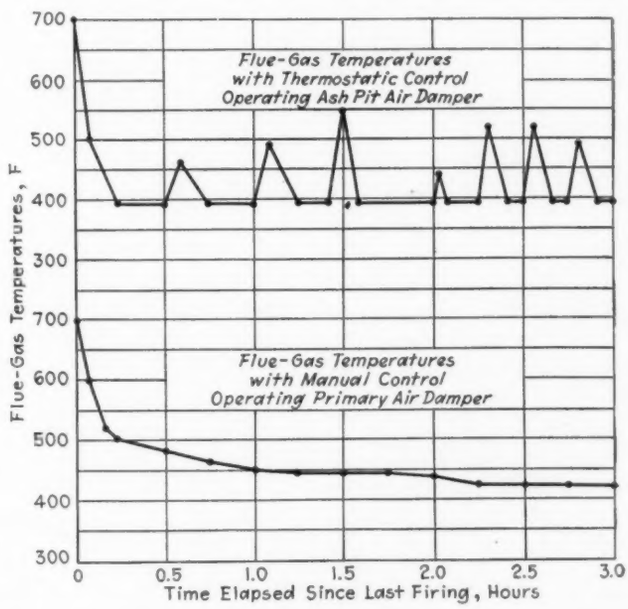


FIG. 3 FLUE-GAS TEMPERATURES WITH THERMOSTATIC CONTROL AND WITH MANUAL CONTROL

fire is less responsive when controlled in this manner, it is sufficiently responsive for satisfactory operation and will not overheat the furnace, even if left turned "on" throughout the complete burning of a charge. This is because the small opening at *A* restricts the air passing up through the bed of coke and the air entering at *B* is limited by the charge of coal through which it must pass. The dampers require little attention if the set-screw at *B* and the opening at *A* are adjusted for the prevailing weather conditions. The curve in the lower part of Fig. 3 shows the flue-gas temperature for three hours after firing, when controlled by this method. The dampers were turned "off" immediately after firing and left in an "off" position

during the entire three-hour period. It may be noted that the combustion rate changed but very little after the first half hour. The temperature at which the flue-gas temperature will "level off" depends on the fixed openings provided at *A* and *B*.

The curves in the lower part of Fig. 4 show the temperature variation in the author's home during a 24-hour period when the dampers were manually operated. Except for one period when the dampers were left "on" too long, the temperature control was practically as good as was attained with thermostatic control. During the 24-hour period, the dampers were not changed except when the burner was fired.

The procedure in servicing the burner when the dampers are manually operated is to turn the dampers "on," shake the grates, poke the coals down to the level shown in Fig. 2, and fill the burner with coal. The dampers are left "on" until the house is comfortable, then they are shut off until it is time to fire again. If the fixed amounts of primary and secondary air are correct, the gas from the coking green coal and the coke below the burner will burn simultaneously at a steady rate to maintain an even temperature in the house until time for the next firing. The average burner installation will require firing four times in 24 hours in normal winter weather. More frequent attention is required in extremely cold weather, while one firing in 24 hours is sufficient to hold fire in early fall and late spring.

No official test data are available, but the author has made a great many observations of the CO_2 with an Orsat apparatus.

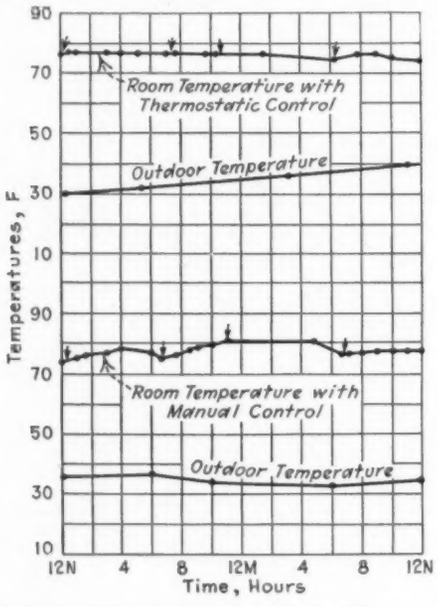


FIG. 4 ROOM TEMPERATURES WITH THERMOSTATIC CONTROL AND WITH MANUAL CONTROL

While CO_2 readings of 15 per cent have persisted for as long as three hours, and 24-hour averages as high as 12.6 per cent have been attained, the data presented in Fig. 5, taken with the burner operating under thermostatic control, are selected as representative of the average CO_2 that would be expected in the weather range represented. It may be noted that the CO_2 did not at any time fall below 10 per cent in less than five hours after firing. The colder the weather, the more frequently the burner should be fired, if efficient combustion is to be maintained. In extremely cold weather it is better to set the thermostat back at night as it is impossible to maintain the desired indoor temperature during the entire night without running the risk of burning out the fuel bed before morning. The thermostat setting was not changed during any of the periods shown in Fig. 5 and the low CO_2 reading at 7:00 a.m. on the cold day was caused by the fuel bed being nearly burned out.

The following typical flue-gas analysis, taken ten minutes after firing, with the chimney check damper open, indicates a good combustion efficiency: $CO_2 = 14.4$ per cent; $O_2 = 2.0$ per cent; and $CO = 0.2$ per cent. A trace of CO is usually found

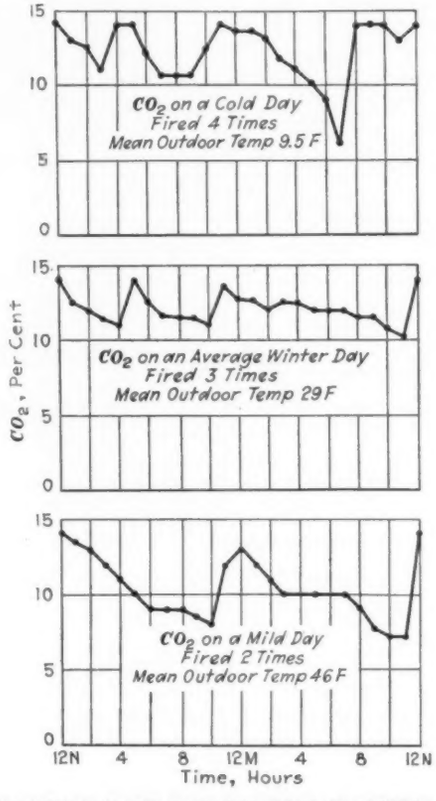


FIG. 5 PERCENTAGE OF CO_2 IN THREE TYPES OF WINTER WEATHER

immediately after opening the check following an "on" period, but is never found at any other time. The total of 16.6 per cent for the CO_2, O_2, and CO would indicate the burning of considerable hydrogen. It may be noted that the percentage of excess air supplied may be very low without producing an appreciable amount of CO.

Experience indicates that the burner, properly adjusted, will enable the burning of any kind of properly prepared bituminous coal without producing any smoke whatsoever. However, the average householder would at times, no doubt, allow the fire to get too low and at other times would poke down coal not completely coked, with the attendant production of some smoke. In extremely mild weather the temperature of the bed of coke sometimes drops below the ignition temperature of the gases, but the amount of smoke produced with the burner would be small compared with that which would be produced in burning the same kind of coal by the ordinary method.

Coal from a number of different fields has been tried in the burner and the results indicate that any bituminous coal, in all sizes except large lumps, can be burned satisfactorily. However, 1-in. or $1^1/_2$-in. dedusted screenings seem to give the best results. A considerable portion of small particles is required for 100 per cent smokeless operation. Also, complete smokeless operation is attained more easily if the coal is fired wet. However, most of the coals prepared for use in the small underfeed stoker burn satisfactorily in the downdraft burner.

The use of the downdraft conversion burner in hand-fired domestic furnaces reduces the smoke to a minimum and much progress has been made in its development.

The INDUSTRIAL RENAISSANCE *of the* SOUTH

By EUGENE W. O'BRIEN

EDITOR, SOUTHERN POWER JOURNAL, ATLANTA, GA.

WE ARE all interested in the South. Most of us have tangible reasons for such interest. The rest of us are interested for a number of current and casual reasons—perhaps the paradox of great wealth of resource and apparent poverty of income, or perhaps concern for the subject assigned to me by the Management Division, "The Industrial Renaissance of the South." Let us discuss this subject with particular reference to these probable interests, both tangible and casual.

The marked industrial advance of the South in recent years is of good cheer to Southerners—it should be of similar good cheer to all this country, for, as we shall try to develop, the South is the key section in American prosperity of the near future. As a matter of fact the only defense the rest of this country has against the lower standard of living in the South is the raising of this standard—the prosperity of the South.

ATTENTION RECENTLY DIRECTED TO CONDITIONS IN SOUTH

Most of you have read the National Emergency Council's "Report on Economic Conditions of the South," and even if you have not, you undoubtedly have read President Roosevelt's presentation of it and recall his crushing statement, "The South presents right now the nation's No. 1 economic problem." This striking summation overshadows other more optimistic comments, such as, "It is an unbalance that can and must be righted, for the sake of the South and the nation," and the statement of the report itself that "The South is the great untapped market of the nation, and the market in which American business can expand most easily."

We of the South can take little exception to this report. It was prepared by a committee of Southerners. Bias cannot be charged. It is merely a statement of facts, but of facts concerned wholly with the problems and the needs of the South not at all with the assets and the opportunities. Those among our good southern friends who criticize it and argue that it is incomplete and unfair forget this point, as indeed the President may have forgotten it in enunciating the brief smashing sentence that has come to epitomize the report itself. Every section has problems, deficiencies, and liabilities, and much that is disagreeable can be written in analyzing them. The South has no monopoly on grievous problems—remember the mine areas of Pennsylvania, the cutover timber lands of Michigan, and the dust bowls of the West. As a matter of fact, there is really nothing new in the report, nothing new, at least, to those who have studied southern conditions.

The chances are that the most useful feature of the report is the dramatization of the conditions it describes, conditions frequently discussed within limited circles, rather than in the great national forum which President Roosevelt and the National Emergency Council now give them. Unfortunately, it is difficult to fix in the average mind the fact that these conditions are limited to the problems and deficiencies of this section; that the report is important not so much for what it says, as for what it does not say.

It is not difficult for those who have studied southern conditions to set up factors on the right side of the ledger to balance this published analysis of the left side, for from practically every economic angle of measurement, the South is today showing greater progress than the country as a whole—in income during the depression, in retail sales, in education, in entertainment, in recreation, in automobile registration, in power output, in highway construction, in manufacture, in life insurance.

Behind these better conditions (compared with national averages) is the better maintenance of income which has been evident during recent depression years. The income of the southern states in 1937 was practically the same as that of 1929, whereas the national average was but 84 per cent of the 1929 figure; 1938 dropped off somewhat, but here again the average drop was much less in the South than in the country as a whole. While figures are not yet complete, I doubt that the income of the area about New Orleans—Louisiana, Texas, and the like—dropped more than 5 per cent in the last year.

Most of this improved income can be credited to industry, for with agricultural and mineral products at the prices which have held for the last ten years, real improvement has come through the South's success in gaining a manufacturing return on the products of its farms, mines, and wells.

It is of this industrial development, particularly the important advance of the last fifteen years, that we should speak.

First let us briefly define the South and its industrial progress up to this period.

WHAT THE SOUTH IS AND WHAT IT HAS

To the average person, the South is the most individualistic of all sections of this country. It is almost a unit unto itself in temperament, history, interests, and customs. Geographically, it is the land south of the somewhat indefinite Mason and Dixon's Line—from Maryland through Texas, from Missouri through Florida. Much of its historic unity has actually been lost through adulteration by northern industry and banking and even by northern politics.

If we were to study this area, using the many varied indexes available, we should find this so-called South rightfully divided into two definite sections which are as different, perhaps, as are the East and the Middle West. These would be the Southeast, that portion east of the Mississippi, and the Southwest. But having stated this distinction, for convenience, let us consider the South as it has usually been considered, a combination of the Southeast and Southwest, with little attention to such border states as Maryland, West Virginia, and Missouri. Keep in mind however, that the South should be considered as an integral part of the nation, not a section set apart.

This South occupies approximately one third of the land area of this country, supports one third of the population, produces one third of the agricultural products, one third of the mineral products, but less than one fifth of the manufactured products.

Contributed by the Management Division and presented at the National Spring Meeting, New Orleans, La., Feb. 23–25, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Despite the fact that this last figure is much lower than the others, the southern states, in their physical and human resources, and in their climate, are well adapted to a highly developed industrial life.

Land wealth is great: In composition it has valuable mineral resources; in location, climatic and agricultural resources; in configuration, power resources; in variety, a self-contained sufficiency not equaled by any other section of the country. The South has mountains and hills, coal, iron, and limestone in convenient location for the manufacture of steel; navigable streams, long coast lines, numerous harbors; convenient hydropower; two thirds of the fuel supply of this country—fuel in its finest forms.

The people of the South are mostly of English and Scotch-Irish stock. Less than 3 per cent of them are foreign-born, as against 14 per cent for the rest of the country, and but 8 per cent are of foreign stock (one parent born abroad) as against 44 per cent outside of the South. In considering unit averages based upon population, it must be remembered that there is a negro population of about 25 per cent, reaching as high as 50 per cent in Mississippi, but this is largely concentrated in the lowland regions where the plantations used to thrive in the raising of tobacco, rice, and cotton. There were never many negroes in the highlands, just as there were never many plantations nor many slave holders. In the last twenty years, there has been a considerable negro migration to the North, which resulted in an increase in percentage of negroes in many northern states of at least five times the percentage of increase in the South (New York, Philadelphia, and Chicago each has more negroes than any southern city—nearly a quarter million each), yet the negro will continue as an economic drag on the South, exaggerating such low figures as per-capita wealth, income, and the like.

INDUSTRIAL PROGRESS IN THE SOUTH PRIOR TO 1923

Industry in the South in its present form is new, as evidenced by new plants, new industries, and new artisanship. But industrial development was not strange to the South early in the nineteenth century. At that time, the South, comparatively, led in industry, with many plants and manufacturing enterprises. More cotton was manufactured in 1810 in Virginia, South Carolina, and Georgia than in the rest of the country. Power textile machinery was used in South Carolina before the Slater mill was built in Rhode Island. There were spinning jennies in 1787 at Charleston and water spinning frames at Statesburg. Chemical plants—potash, glass, salts, indigo—dotted the Southeast early in the 1800's.

It was a Connecticut Yankee and a mechanical invention—Eli Whitney and his cotton gin—which indirectly caused the shift from industry to agriculture. The cotton gin made possible the mass separation of cotton fiber from the seed. The South was best fitted to raise cotton and the industrial revolution in England created greater and greater demands for the cotton. By 1860, two fifths of the wealth of this country was concentrated in the South—but one third of the population was enslaved, and this condition effectively discouraged foreign immigrants who had an industrial background. The South furnished cotton, and depended upon England and the North for manufactured products.

And yet, even then, farsighted men like William Gregg, of South Carolina, constantly preached the advisability of stimulating manufacture and warned that an agricultural people would always be a poor people, enslaved by economic conditions as surely as their negro help. The spark of manufacture was nourished and kept alive, partly to take care of the poor white of the highlands. As a matter of fact, the value of manufactured products of the South compared with that of the whole country in 1860 varied little from that in 1920; it was largely built about local demands, with textiles ranking fifth instead of first, as now, and being led by flour and meal, lumber, tobacco, and iron.

The Civil War broke cotton. Exports dropped from 3,000,000 bales in 1859 to 10,000 in 1862. Egypt, Africa, and South America began to raise cotton, and substitutes were developed. The great wealth of the South was sadly dissipated. Yet despite the fact that the most glaring need of the Confederate States during the war had been the manufacturing they had neglected before it, efforts after the War were largely devoted to reestablishing King Cotton, not to restoring manufacturing. If anything, manufacturing trailed along behind a generally slow recovery. It was not until 1900 that industry began to assert itself. Since that time, the rate of increase of the South's manufactured products has been 50 per cent greater than that of the rest of the country. The value is now some nine billions annually.

GROWTH OF INDUSTRY IN SOUTH SINCE 1923

The percentage of the total "Value of Manufactured Products" for the United States which the South enjoyed in 1923 was practically the same as it had been in 1860. Most of the advance made by the South during the long postwar period has come in the last fifteen years.

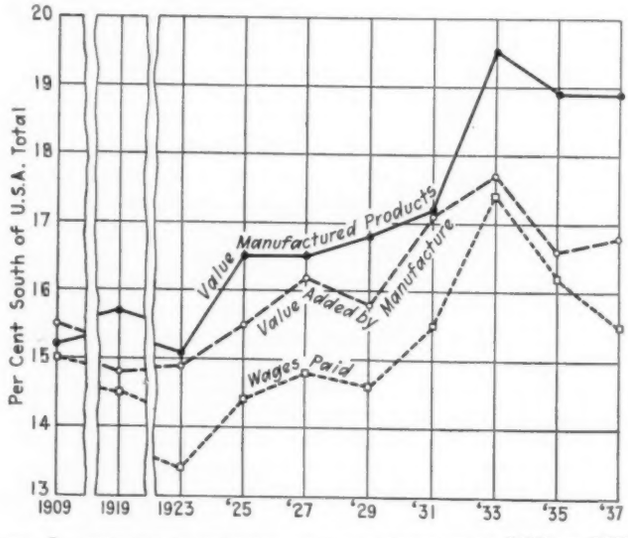


FIG. 1 GROWTH OF INDUSTRY IN THE SOUTH FROM 1909 TO 1937

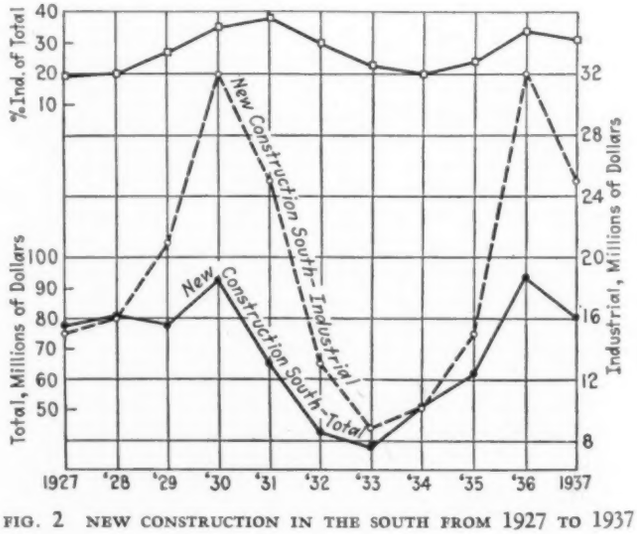


FIG. 2 NEW CONSTRUCTION IN THE SOUTH FROM 1927 TO 1937

In Fig. 1 are shown the basic figures which best reflect the sound and substantial growth of southern industry in this interval. The three curves show the changes in the position of the South with respect to the country as a whole over the period from 1909 to 1937, but stress in detail the changes recorded by the biennial census, beginning with 1923 and ending with 1937. Of particular note is the fact that the value of manufactured products has risen from 15.1 per cent in 1923 to 18.9 per cent in 1935 and 1937. This may not seem a large increase, but it is a 25 per cent gain in the South's position.

At the same time the "Value Added by Manufacture" rose from 14.9 to 16.8 per cent. The fact that this rise is not so great as that of the value of manufactured products reflects the type of industry common to the South, an industry close to the basic raw materials, often serving other industries which serve the consumer; for instance, the new heavy chemical plants serve paper, fertilizer, textile, and other such plants.

During the same interval "wages" rose from 13.4 to 15.5 per cent, a 16 per cent gain.

Not shown on this chart is the fact that from 1860 to 1923 there was little change in these basic indicators. In 1860, just before the War, the South boasted of 15 per cent of the national value of manufactured products and 13.5 per cent of the wages, as against 15.2 and 15 per cent in 1909, 15.7 and 14.5 per cent in 1919, and 15.1 and 13.4 per cent in 1923. As stated before, the sustained rise of the last fifteen years has been the important rise in southern industry.

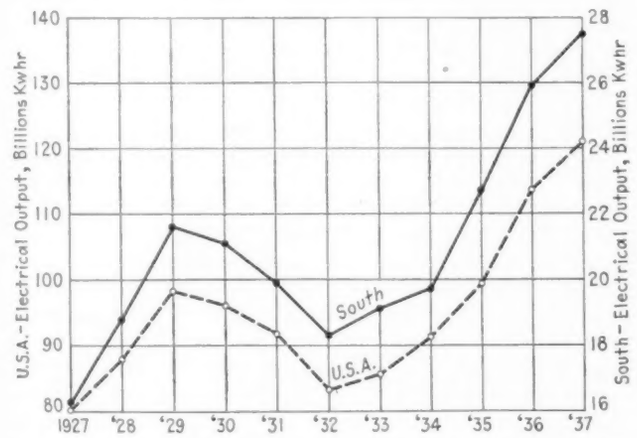


FIG. 3 GROWTH OF ELECTRICAL OUTPUT IN THE SOUTH FROM 1927 TO 1937

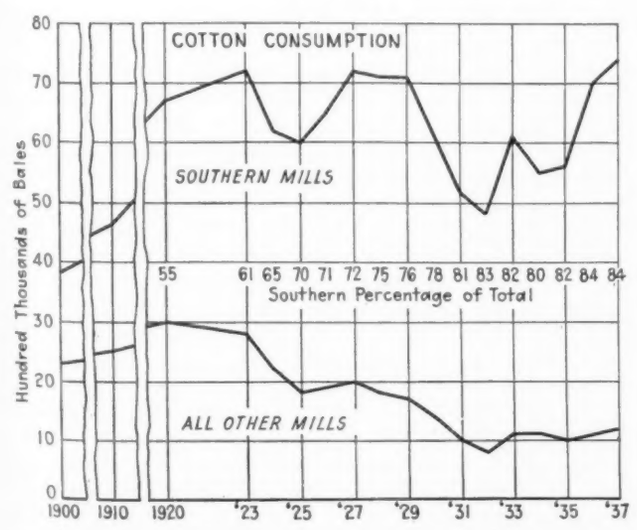


FIG. 4 COTTON CONSUMPTION IN SOUTHERN MILLS FROM 1900 TO 1937

Fig. 2 reflects more directly this recent forward surge of industry. Starting with 1927, for that is as far back as our records are complete, we have plotted both the "New Construction South—Total" as given by *Manufacturers' Record*, and the "New Construction South—Industrial" as collected by *Southern Power Journal*. These latter figures vary slightly from comparable figures from other sources, but so slightly as to suggest general accuracy. It will be noted that starting with about the same trend in 1927 the industrial construction becomes much steeper in its ups and downs than the total construction, having much more to do with the peaks and valleys of the total construction curve than do other factors in its make-up. In the topmost curve are shown the changes in the percentage which the industrial construction is of the total construction in the South. This started about 20 per cent, and in 1937 was about 30 per cent, during a period in which the value of manufactured products, as indicated by the previous curve, had risen from about 15 to 19 per cent. In all probability it is fair to assume that the rising percentage of new industrial construction means continued rise in the value of manufactured products. It is gradually removing one of the South's deficiencies, lack of production facilities.

Fig. 3 shows the electrical output of the United States and of the South, starting again with the 1927 census, to make it comparable with Fig. 2. It shows an approximate rise in the southern percentage of the United States total from 18.5 to 22.5 per cent, measuring further the advance of this period.

Much of the industrial gain of the South during this period can be credited to a number of industries to which the South offers particularly fine opportunities for profitable exploitation. The one that comes most naturally to mind is the textile industry. This always has been an important industry in the South, even though for a long time the emphasis was on raising cotton rather than processing it. It took the South a long time to realize that greater return came from cotton as thread and cloth than from cotton as fiber.

Thanks to the efforts of William Gregg and other leaders toward interesting the South in textile manufacture, by 1900 the South was consuming about 39 per cent of the cotton processed in textile mills in this country. By 1910 this figure had reached 45 per cent; by 1920, 55 per cent; by 1923, 61 per cent. As can be seen from Fig. 4, this percentage has risen steadily from that time until, in 1936 and 1937, 84 per cent of the cotton consumed in this country was processed in southern mills. See Fig. 4. Comparable gains can be shown in active spindles and active looms in Southern mills.

Perhaps the greatest advance in recent years has been in associated textile lines, the rayon industry, with 70 per cent of the capacity of this country in the South producing more than $100,000,000 worth of yarn a year, and the knitting industry, producing more than $150,000,000 worth each year.

CHEMICAL AND PULP AND PAPER PLANTS BRING NEW INDUSTRIES

Next in substantial growth over a recent extended period of time is the chemical industry. Here again there were many plants in the early days, most of which were small and produced diversified products, but with some heavy chemicals, such as sulphuric acid, manufactured in considerable quantities. The growth of textiles, particularly rayon, had much to do with southern chemical development by offering a local market to add to natural resources as inducement for southern plant construction. More than 60 per cent of the chemical-plant construction in this country during the last four years has been in the South. Of particular interest has been the cellulose plants and the heavy-chemical plants producing caustic soda, soda

ash, chlorine, sulphur, and the like, which serve the cellulose, fertilizer, and other chemical-engineering producers of direct commodities. As is well known, these chemical plants usually serve intermediate manufacturers and not ultimate consumers. In the Louisiana area, there is particular interest in the use of valuable petroleum resources, brines, natural gas, and the cheap power, which are available for the production of sulphur, caustic soda, soda ash, chlorine, and the like (98 per cent of the world's sulphur is produced in this area by the so-called Frasche process).

Perhaps the most explosive, the most sparkling, of all southern industrial developments can be credited to this general classification of chemical industry, the production of pulp and paper from southern pine, in which well over $100,000,000 has

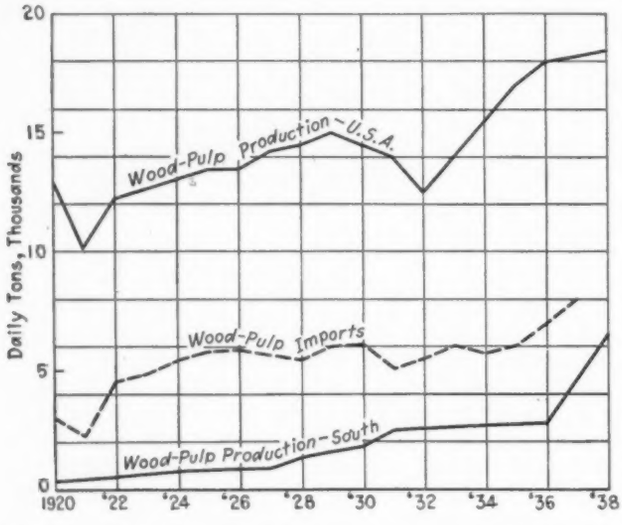


FIG. 5 GROWTH OF WOOD-PULP PRODUCTION IN THE SOUTH FROM 1920 TO 1938

been spent in new construction in the last three years practically doubling the 1935 productive capacity of 4000 tons per day. See Fig. 5.

The manufacture of pulp and paper in the South really started at Braithwaite, La., about twenty miles below New Orleans, where an English company built a plant in 1898 to make paper from bagasse. This plant failed, but became successful when it was leased in 1915 by what is now the Gulf States Paper Corporation and operated as a pine pulp plant. This plant was moved to Tuscaloosa, Ala., in 1931.

In 1903, five years after the Braithwaite start, a plant was built at Pensacola, Fla., failed to make paper from Southern pine with commercial economy, was later bought by the Lutcher-Moore interests, and moved to Orange, Texas. Success finally came to this plant in 1911, when Edward H. Mayo, generally known as the father of kraft paper, changed the process from soda to sulphate. A second mill to use this process, financed by English money, was built in 1913 at Moss Point, Miss., and is still in operation as a part of the Southern kraft group.

But it is within the last three years, thanks to the successful research and promotion of the late Charles Herty and various members of the technical staffs of the principal paper companies, that the industry really blossomed forth into a major element in southern progress.

Most of this development has been in the sulphate, or so-called kraft-paper field, and the product is largely used for wrapping paper and containers of various sorts. One new mill, that of the Fernandina Pulp & Paper Company at Fernandina, Fla., uses the sulphite process, with its product going into rayon. A plant under construction at Brevard, N. C., will make cigarette paper, first from foreign linen rags and later from flax raised in the Southeast. A new mill just started at Lufkin, Texas, underwritten by southern newspaper publishers, is designed to manufacture newsprint. This plant will cost about $6,000,000, and will produce about 200 tons of newsprint per day. Inasmuch as between $150,000,000 and $200,000,000 a year is spent for foreign newsprint pulp, the importance of this development as a probable forerunner of many others may well be imagined.

REASONS FOR GROWTH OF INDUSTRY IN SOUTH

We might go on talking about other industries, such as that of furniture in which production increased from 10 per cent of the country's total in 1910 to 25 per cent today, but I am sure that there is greater interest in the reasons behind the migration of old plants into this area, the opening of southern branch plants by long-established northern industries, and the expansion of southern industry itself through new plants. What causes these industries and these plants to choose the South, or some particular section of it? Industry usually prefers to grow, rather than to move.

The reasons behind the movement of industry to the South are common to any study of plant location, whether the location be in the South or elsewhere. Under new conditions of increased taxation, uncertain labor cost and efficiency, keener competition, greater limitations of price, many industries have had to study more carefully every possibility of greater economy in production with production costs varying materially from section to section and community to community.

These variations should be the subject of careful, informed study. Industry and community have mutual interest in long-term success, a fact which is being more and more recognized by communities themselves, and by their chambers of commerce. Communities are interested in new industry because it gives jobs to increased population, keeps youth at home, raises the standards of living, brings better health, better education, local markets, and taxable wealth—the abundant life for which we all yearn, but which cannot be attained if the industry, because conditions are not suitable, ceases to thrive.

The factors which vary widely from locality to locality also vary widely in their importance to the industry, to the particular plant, and in many cases to different individuals in the same industry and plant. The principal factors are discussed here with respect to their probable general importance in the studies which have resulted in location of industry in the South.

Perhaps first in general importance are the raw materials of the South. Figures are so well known that it seems unnecessary to establish here the fact that in the South there is the greatest store of undeveloped natural resources in this country—resources of soil, mine, and water. The advantages of processing these resources at their point of origin are obvious, and have had more to do with southern industrial growth than any other.

Why should not industry be interested in a section which can boast of one half the forest resources, one half the water resources, one half the coal resources, nearly one half the mineral resources, well over one half the aluminum resources, practically all the sulphur, phosphate, carbon black, and fuller's earth, two thirds of the petroleum and gas resources, and associated salt brines to give caustic soda, soda ash, chlorine, and other chemicals?

Yet it is probable that in casual discussion of southern characteristics favorable to industry, labor is most often stressed, because southern white labor is largely an undeveloped labor, free from rackets which sometimes parade under the guise of respectable labor unionism. There is, of course, a differential

in the wages of labor—perhaps a differential of 20 per cent—but this is gradually decreasing to the point where it will simply reflect the differential of living costs under conditions of comparable comfort and convenience.

Charges are sometimes made that southern labor is not skilled. This has not interferred with its widespread absorption by northern industry, which has secured far more from the hills and the plantations of the South in recent years than by immigration from elsewhere. It is this emigration from the South which southern industry hopes to stop, by offering job opportunities that did not exist under the old agricultural economy. Southern labor has time in its favor, for there are more young men in the South than in the North, on any basis of comparison. Much of the advance of the South depends upon keeping these young men here—particularly those who are well-educated—instead of shipping them away, as has been done in the past.

Fuel and power and water are fundamental to industrial development, and exist in the South in more usable quantities and forms than in the rest of the country. Of prime movers, there are one third of the hydrounits, one fifth of the steam units, and one half of the internal-combustion units, with more than 60 per cent of the annual output derived from fuel. Half of the country's coal and two thirds of its petroleum give fine advantage to decentralization of industry by justifying isolated plants, both steam and Diesel, wherever needed. A member of the National Resources Committee stated recently that three quarters of the fresh-water supply of the world is located on the North American continent. In the United States, half of these resources are in the South. How important this is will be testified by the paper mill, the rayon plant, and the chemical plant which have recently come here.

FINANCIAL INDUCEMENTS HAVE HELPED

Taxes have also been stressed in explaining the movement South, for in general southern taxation is more friendly to the industry it wants than is taxation in other sections of the country where industry is already established. Not only are taxes more reasonable, but legislation is more fair, and the general philosophy behind these factors seems to guarantee greater security from future governmental interference and uneconomical levies.

The great rivers, the long coast line, and excellent harbors make the South the most favored section of the country in so far as water transportation is concerned. Good new roads, fine airways, and railways help transportation further. There is still much to be done toward reaching a fair parity of freight rates on manufactured goods moving out of the South, and to offset rates set up years ago to favor the industrial areas of the North. For the first time in history, determined efforts are being made to accomplish this purpose.

Undoubtedly of first importance in marketing is the market of the South itself, which has been served but in small part by southern industry. It has been common practice to ship natural products out of the South, to be processed into consumer goods and shipped back for sale to the section which produced the raw material. Increase of industry and improvement of income and purchasing power make this southern market the greatest incentive. Yet southern regions are accessible to the northern markets and already do a considerable finished-product business with them.

Construction and real-estate costs are unquestionably lower in the South, at least 15 to 20 per cent lower, although the differential varies widely in particular cases. These also have favorable influence on rent, insurance, and financing.

Living costs and housing are bound together in their influence on favorable labor and plant-location conditions. Improvement is being made steadily. While it is true that we are developing mechanical means of controlling climate in the industrial plant, with the cost of cooling often balancing that of heating, this goes but a small way toward offsetting the more equable climate the South as a whole can boast. Believe it or not, a good part of the South is more comfortable in the summer than a good part of the north.

Bonuses for plant location have been offered by every section of this country, more particularly by the South in recent years. Here in Louisiana there is a tax-exemption law which has helped materially in attracting new industries. In Mississippi it is possible to secure public financing and rent-free plants for industrial establishments designed to use Mississippi's raw materials. Still more important than bonuses are friendly laws relating to working conditions and hours, compensation insurance, taxation, social security, labor relations, and factory inspection, which reflect a spirit helpful to industry. Bonuses should be considered principally a helping hand to getting started. If they attempt to replace the more basic characteristics needed by industry, they are dangerous and uneconomic.

We have heard much in recent years about decentralization of industry. The greater comforts, conveniences, and incomes of the centralized industrial areas have attracted the less fortunate rural population and have inevitably resulted in greater increase in population than in jobs. Inability of industry to "job" this increase has resulted in much of the discontent noted in these areas in the recent past. This fundamental condition, the fact that machines have minimized the importance of the individual dexterity and skill usually concentrated in such areas, and the further fact that the development of public-utility systems and isolated power units have made possible the setting up of industrial plants far afield where lower living costs can be reflected in wages and profits and where comforts and conveniences comparable to those of the city can be offered, point the way to decentralization. Decentralization is more a fact in the South than elsewhere, and plants are widely dispersed.

These are perhaps the principal characteristics which industry has considered carefully in choosing the South for expansion. Many mistakes have been made, but it is a matter of record that practically all of the expansions into this territory have been profitable. There is crying need for a more careful study of plant location by those coming South and there is a real place for informed consultation services in the choice of the general region, the specific locality, and the particular site of a plant. Just as great is the need of analytical study by localities themselves of their own particular strengths and weaknesses, and of the types of industry which can best be served by these characteristics. Such a study has not been made comprehensively for any large section of the Southland, although it is reported that much has been done by Mr. Jahncke's committee in Louisiana.

LACK OF EDUCATIONAL FACILITIES THE SOUTH'S GREATEST DEFICIENCY

We have spoken principally of the advantages of the South with respect to the ordinary factors determining industrial development. In general, we have pointed out that there are in the South great natural resources, the finest of human resources, and a new psychology that shows a greater disposition to study these resources and market them intelligently and to seek a "finished goods economy" as against a "raw materials economy." After the National Emergency Council's report little need be said about deficiencies, except to give personal observations as to the more important of these.

The most important deficiency is lack of educational facili-

ties, which means that the South has not realized, has not understood, by and large, the great opportunities it was missing. There are more young to educate, less money for education, and greater loss in education investment, through migration, in the South. Valiant efforts are being made to correct this fundamental educational weakness, as will be noted in new trade schools, and in its highest form, in engineering schools like Tulane University and Louisiana State University.

There is the one-crop philosophy to contend with, be it a cotton or tobacco or petroleum crop, that results in a depletion of local natural resources without taking full advantage of the profitable possibilities of processing these resources. This philosophy is inevitably passing.

There is a lack of health facilities, though material improvement has been made in the last fifteen years, despite the handicap of low income and ignorance.

There is a lack of technical heritage and background and of industrial skill, despite the excellence of labor in general. There is a lack of developed energy of various sorts, of productive and industrial means, plants, and machinery, though this is largely being corrected by the higher tempo of southern industrial construction.

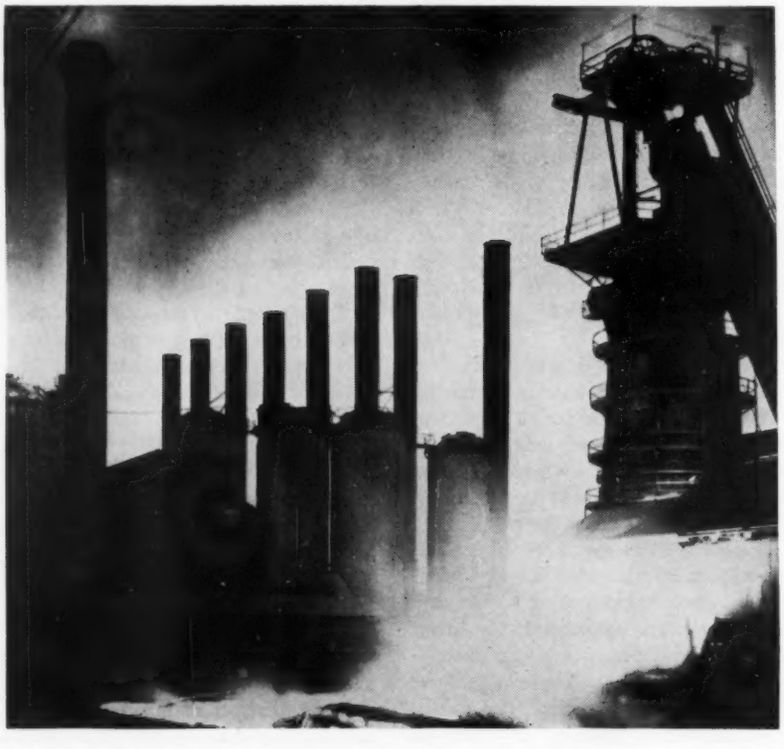
There is the handicap of unfavorable freight rates to overcome, for rates between the southern and southwestern territories and the eastern or official territory, designed in years past to favor the congested industrial districts of the North, give low rates on raw materials, and high rates on manufactured goods, going north, and, vice versa, on similar goods going south. Authorities estimate that there is a 39 per cent differential against class goods (manufactured goods) going from the South into the North. On all goods, this differential is estimated as approximately 15 to 20 per cent. It is expected that the current drive to secure parity—not necessarily lower rates, but parity—will meet with general success, and materially improve the position of the South as a manufacturing region shipping into northern markets.

There are also the disadvantages of lower income, lower purchasing power, and the wage differential, which only time and increased industry can correct.

There has been too great a tendency on the part of southern people to look elsewhere for leadership in the financing, in the construction, and in the direction of their enterprises, partly due to original need and partly to lack of "venture spirit" and "venture capital." Fortunately, a new psychology seems to be shaking off this tendency to say, "Well here it is, you develop it," an attitude that meant in the past that a large part of the profits of southern industry went north of Mason and Dixon's Line.

Perhaps the most important intangible factor in the renaissance of southern industry is a new disposition among southerners to believe that the South can manufacture anything that can be manufactured anywhere else under similar advantages or disadvantages, and a willingness to plumb the possibilities of further use of its great resources, first to serve its own people and then to sell at a profit elsewhere. This has been demonstrated in a much broader view of agriculture, particularly in the raising of new crops which are subject to processing and to development of the so-called chemurgic industries. Many projects are on foot to produce more quality products for agriculture—more profitable products from sweet potatoes, pecans, rice, tung nuts, and soy beans. There is an eagerness to forget the ills of the past, to end excuses for past derelictions, and to take more aggressive hold of the great possibilities ahead.

In closing let us recall that paradox. The South has long been a rich section living in comparative poverty. There was, and is, fine climate for all people; rich soil for the farmer and chemical engineer; and minerals, forests, and fuels for the industrialist. But a long-dominant agriculture has paid less than half an industrial wage, and has kept the South poor. The last fifteen years have shown a notable renaissance of industry. Industry has even begun to dictate to agriculture what it shall raise, and is already processing half the farmer does raise. It is gradually bridging the vast chasm which has long existed between the possibilities and the actualities.



"IRON MAKERS" AT NIGHT—FURNACE SCENE AT BIRMINGHAM, ALA., AN INDUSTRIAL CENTER OF THE SOUTH

Latest Developments of the BENSON BOILER

II—Description of Typical Installations

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A FEW OUTSTANDING Benson boiler installations are described in this article, which is the second and concluding part of this contribution.

For purposes of testing turbines two Benson boilers with a maximum continuous rating of 55,000 lb per hr each, have been installed in the Muelheim Works of Siemens-Schuckert Werke. The Benson boiler is particularly suitable for such service due to the fact that it may be operated at any desired pressure and temperature. As this plant is in service only for short periods, the fuel expenses are of little importance as compared to the investment, so that the boilers (manufactured by Duerrwerke) have been equipped with a combination gas-oil firing. For the same reason, no air preheaters have been provided.

Fig. 7 shows a general view of this boiler, and Fig. 8 gives a sectional view. The very small dimensions are particularly interesting. The heat release in the combustion chamber is 1.65 million kcal per cu m per hr (185,000 B per cu ft per hr), at a boiler output of 55,000 lb per hr. The boiler construction is similar to that used for marine boilers. The combustion chamber operates under pressure above atmospheric pressure and no induced fan is provided. The boiler is enclosed by an airtight, double, sheet-metal shell. The air necessary for combustion is forced through the space between the two shells, thereby circulating about the entire boiler and thus very effectively decreasing the radiation losses.

From the shells, the air is brought directly to the two gas burners. The pressure between the shells is always higher than in the combustion chamber by the pressure drop in the burners. Therefore, it is impossible for flames or flue gases to escape to the atmosphere.

The combustion chamber is lined on all sides, with the exception of the burner side, with tubes of $^{21}/_{29}$ mm diameter (0.83/1.14 in.), which are connected in parallel in groups of 18, forming tube elements with bottom-to-top circulation. Each tube element is connected to the next one by means of a common downcomer. In the second flue, coiled tubes of the same size are employed and are arranged in groups of 24. Circulation of water and steam, respectively, through the various parts of the heating surface is in the following sequence: water preheater, radiant-heat-absorbing section, transition section, superheater. Circulation through the water preheater is in countercurrent flow, through the other parts in parallel flow with respect to the flue gases. This is necessary with the vertical single-flue-type boiler because of the desirability of the water and steam mixture always traveling upward against gravity within the tube systems. The material for the water preheater tubes is St 45.29 carbon steel, while TH 30 molybdenum steel is used for the transition section, radiation section, and superheater. It is seen that no really high-grade steels are employed. This plant was placed in service in July, 1936, since when no operating difficulties have been experienced.

Another large Benson boiler installation is at Scholven in the Ruhr district, which supplies power and steam to a large chemical plant, and consists of five boilers with a maximum continuous rating of 220,000 lb each. The boilers were furnished by Duerrwerke and Rheinmetall-Borsig. A sixth boiler is under construction. The heat-flow diagram is shown in Fig. 9. Steam is generated at 1780 lb per sq in. and 990 F. This high temperature was used for the first time in this plant in continuous operation. The steam is reduced to 185 lb in Ljungström turbines and is then reheated by means of heat exchangers in

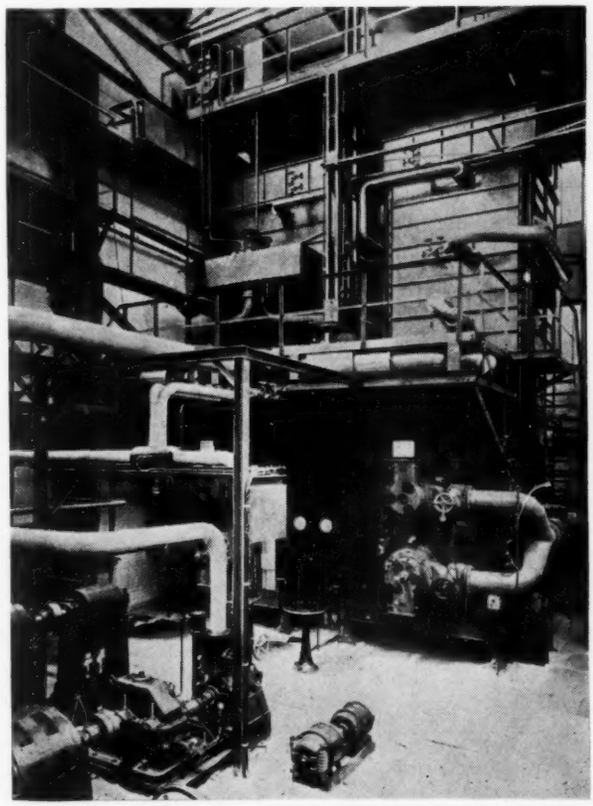


FIG. 7 BENSON BOILER PLANT IN THE S.S.W. MUELHEIM WORKS, WITH OIL AND GAS FIRING

(Maximum steam generation, 60,000 lb per hour; pressure, 450 to 2130 lb per sq in.; temperature, 890 to 930 F.)

Contributed by the Power Division and presented before the Metropolitan Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y., Oct. 19, 1938. Part I on the review of early problems was published in the March issue of MECHANICAL ENGINEERING, pp. 217–221.

FIG. 8 SECTIONAL VIEW OF BENSON BOILER IN THE S.S.W. MUELHEIM WORKS, WITH OIL AND GAS FIRING

which the initial live steam is the heating medium. This explains the reason for the initial high steam temperature that is employed. In this manner the high-pressure turbines receive steam at a temperature of only 842 F. A large part of the steam is sent by way of heat exchangers to heat-absorbing apparatus, the rest to condensing turbines. In parallel with the new installation are a 412-lb boiler plant and a 185-lb plant, which, however, has since been taken out of service.

The design of the first three boilers is shown in Fig. 10. These boilers are equipped with Kraemer mills furnished by Babcock & Wilcox and Borsig. The fuel employed is a low-grade slime[2] coal of 7200–8100 Btu per lb lower heat value, of a moisture content up to 25 per cent, and ash content up to 30 per cent. It is dried in the mills by means of the preheated air at a temperature of about 750 F.

When the plant was first placed in service, it was found that the temperature of the flue gases was much below the computed value of 390 F because the radiant-heat-absorbing section and also the other parts of the heating surface remained entirely clean in spite of the great ash content of the fuel. Since the boilers operate under natural draft and the effect of the water preheater was such that superheat was found to obtain at the end of the radiant-heat-absorbing section, it was decided to remove the water preheaters in order to (1) obtain higher flue-gas temperatures for proper chimney draft, (2) remove the condition of superheat from the radiant-heat-absorbing section, and (3) raise the temperature of the preheated air which had not attained its desired value due to the low flue-gas temperatures. In acceptance tests an efficiency of 84 per cent was obtained under normal boiler loads of 154,000 lb per hr.

[2] By "slime coal" is meant waste fuel from washing and screening.

No serious difficulties were experienced with the Benson boiler proper. Some trouble was occasioned by defects in the material used and resulted in a few burst tubes in the radiant-heat-absorbing section and superheater. Some leaks at welded points were also experienced, but easily remedied. Gas welding had been employed for connections in the radiant-heat-absorbing section, superheater, and transition section of the boilers. The tubes of the water preheater, however, were electrically butt-welded. Many of these welds were porous and the failure was probably caused by the fact that the welded parts had been filed down for better appearance, exposing porous welding. These difficulties were eliminated when the water preheaters were removed for the reasons given.

The welds on the Benson boilers were not annealed because it was felt that annealing would be of disadvantage rather than advantage, due to formation of scale inside the tubes during the process. Only the welds on high-grade steel alloys must be annealed. Such material has been used for the superheaters at the Scholven plant, namely "Sikromal" steel CS 65, a silicon-molybdenum-chromium steel. A molybdenum steel TH 30 has been used for the radiation and transition sections while the 45.29 quality of normal carbon-steel tube was employed in the water preheater before it was removed.

The quality of the welding being largely dependent on the workmanship, it has been found expedient in Germany to have the welders undergo a test before they are assigned to their work. This practice has been effective in the United States for several years.

Greater difficulties were caused by slagging on the burner side of the combustion chambers which is not lined with tubes. Large amounts of slag formed near the burners and occasionally dropped onto the water screen below, which was bent out of shape. The brickwork at these points was also damaged within a short time. Based on these experiences, the con-

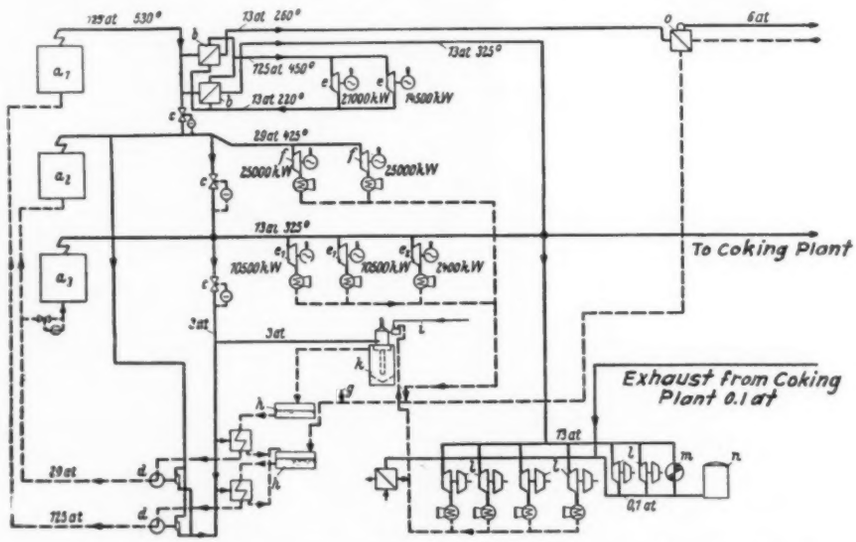


FIG. 9 HEAT-FLOW DIAGRAM OF SCHOLVEN POWER PLANT WITH BENSON BOILERS

(Maximum steam generation, 220,000 lb per hour, each; pressure, 1780 lb per sq in.; temperature, 990 F.)

a_1 Five 125-atm, 100-ton per hr Benson-type boilers
a_2 Six 29-atm, 35-ton per hr boilers
a_3 Two 13-atm, 12-ton per hr boilers (reserve)
b Intermediate superheaters
c Pressure-reducing valves
d Feed pumps
e Ljungström superimposed turbines
e_1 Ljungström condensing turbines
e_2 House turbines
f Double-casing axial turbines
g Distillate from evaporator
h Feedwater tank
i Make-up water
k Chemical feedwater-treatment plant
l Turbocompressor
m Winding engines
n Exhaust-steam storage
o Heat exchanger

struction of the succeeding boilers Nos. 4 to 6 was changed as shown in Fig. 11. A water-cooled hopper was substituted for the water screen, and the lining of the combustion chamber was improved so that it offered more protection to the brickwork than in the original construction. Since it had been found that for very moist fuel and particularly under partial load the preheated air was insufficient to dry the coal completely, means were thereupon provided for supplying gases from the combustion chamber to the mills. The Ljungström air preheaters originally employed were not found satisfactory due to considerable leakages, so that plate-type air preheaters have been supplied for the three new boilers. In the meantime, however, a new construction of the packing has remedied the trouble so that today the performance of the Ljungström air preheaters is equal to that of the plate type. The first two boilers have been in continuous operation since November, 1936, and the third boiler since January, 1937.

Not oftener than every three months, the boilers are flushed, and sometimes at shorter intervals, if they have to be taken out of service for other operating reasons.

The fourth boiler was placed in service in May, 1938, and the fifth boiler in August, 1938. These two boilers also operate entirely satisfactorily, and trouble with slagging has been completely eliminated. The boilers described in the foregoing are equipped with the automatic electric regulation system developed by Siemens and Halske, referred to previously in this article.

Two boilers of similar construction were placed in service by the Niederschlesische Bergbau A.G. at Waldenburg in October, 1937. The construction is similar to that shown in Fig. 10, the first Scholven boiler, however, without a water screen. These boilers, which were manufactured by Rheinmetall-Borsig, have also been in satisfactory operation since their installation. With the exception of considerable slagging, no serious difficulties have been encountered. These boilers operate for mining purposes at a pressure of 1780 lb and a steam temperature of 932 F. The steam is first used in a high-pressure turbine down to 199 lb, then reheated in gas-heated intermediate superheaters, and finally taken to a condensing turbine. A small part of the steam is sent to the coking plant. St 45.29 carbon steel has been employed in the construction of the water preheater, and TH 30 molybdenum steel for the other heating surfaces. The boilers operate with an exit gas temperature of 320 F.

In this plant, some trouble was experienced with boiler ac-

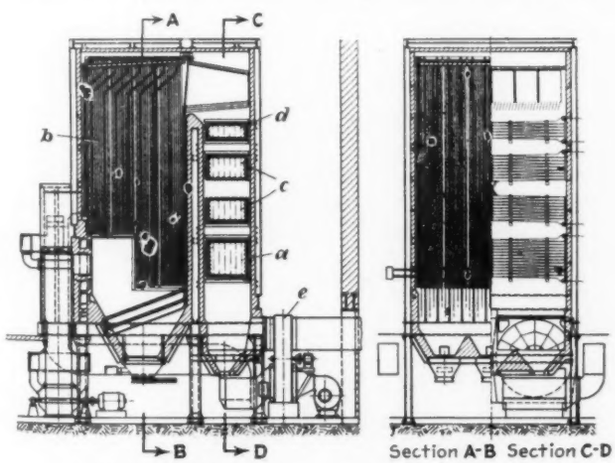


FIG. 10 BENSON BOILER AT SCHOLVEN, WITH MILL FIRING
(Original construction.)

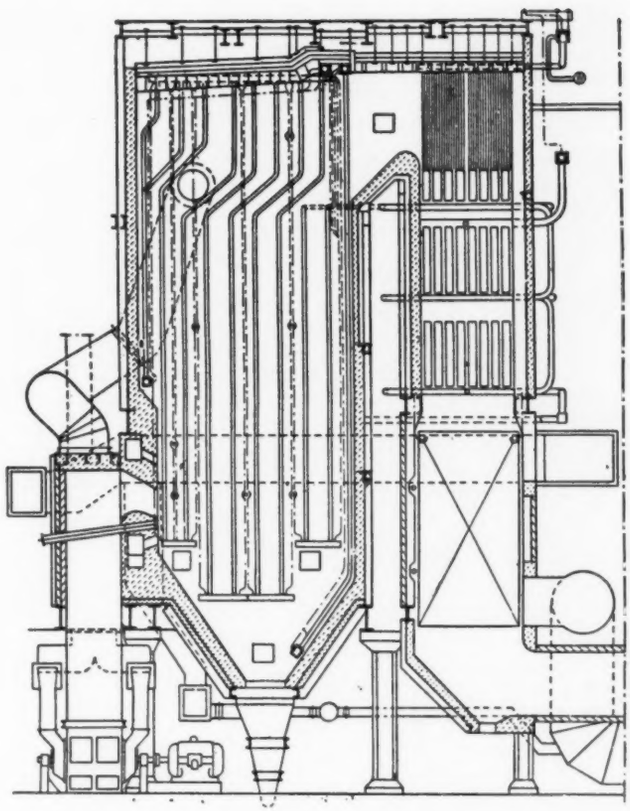


FIG. 11 BENSON BOILER AT SCHOLVEN
(Improved construction, without water screen; with combustion-chamber gas supply to the mill.)

cessories, as for example, with the valves which regulate the feedwater supply. These valves are equipped with electric drive, which is controlled by the automatic boiler-regulation system. The valves are of the single-seat type, in which great forces are exerted on the spindle. Because of incorrect design of the spindle guide the valves jammed and caused failure of the drive.

In one case the valve cone became detached from the valve stem and became seated on the valve seat so that the feedwater supply was completely interrupted. In the absence of automatic alarm equipment, the boiler-room crew did not discover the difficulty in time and was too late in interrupting combustion so that the steam temperature rose excessively and caused a superheater tube to burst. However, it was also found that the material of the burst tube had been defective. The tube was repaired in a few hours. The loss of feedwater experienced in this case would have had serious consequences with a drum-type boiler, and, no doubt, would have caused a long interruption to service.

Another new Benson boiler, manufactured by Rheinmetall-Borsig, has been installed in the S.S.W. Cable Works. Unlike the two other installations, this boiler is equipped with exclusive powdered-coal firing with intermediate powdered-coal bunkers. The arrangement of the combustion chamber and second flue is practically the same as that of the boilers at Scholven. Construction details are shown in the following figures, which were taken during construction.

Fig. 12 shows the Benson boiler, looking down into the combustion chamber, with water screen at the bottom and powdered-coal burners on the far side.

Fig. 13 shows the upper part of the combustion chamber with radiant-heat-absorbing section at the point of flue-gas turn to

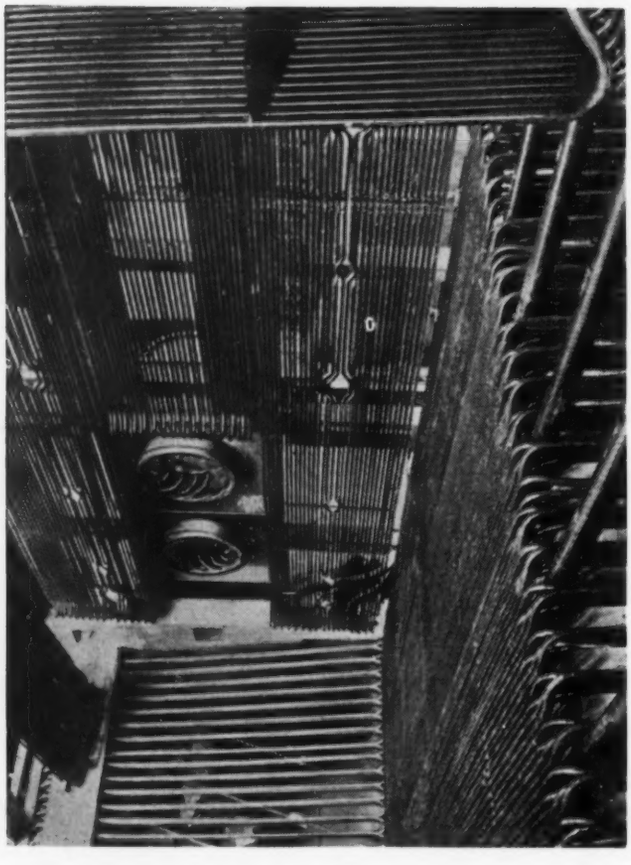


Fig. 12

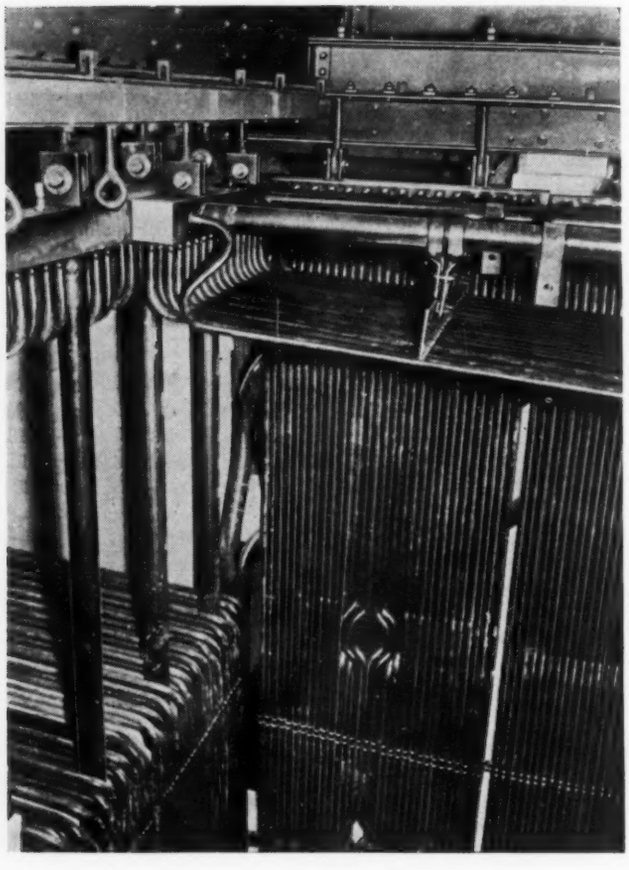


Fig. 13

FIG. 12 BENSON BOILER IN THE S.S.W. CABLE WORKS, LOOKING DOWN INTO COMBUSTION CHAMBER WITH WATER SCREEN AT THE BOTTOM AND POWDERED-COAL BURNERS ON FAR SIDE; MAXIMUM STEAM GENERATION, 110,000 LB PER HOUR; PRESSURE, 2910 LB PER SQ IN.; TEMPERATURE, 892 F. FIG. 13 BENSON BOILER IN S.S.W. CABLE WORKS; UPPER PART OF COMBUSTION CHAMBER

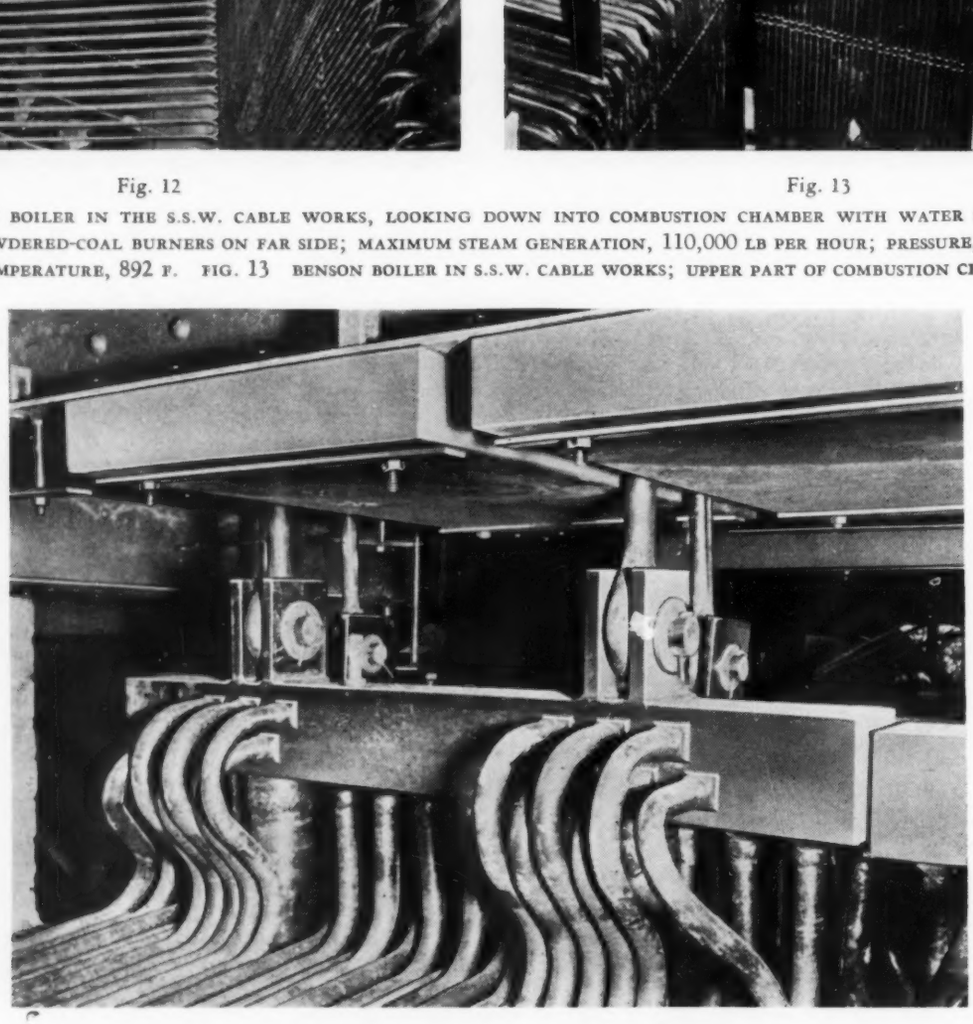


FIG. 14 BENSON BOILER IN S.S.W. CABLE WORKS
(Method of suspending tubes of radiant-heat-absorbing section.)

the second flue. Fig. 14 shows the method of suspending tubes of the radiant-heat-absorbing section.

Fig. 15 shows the method of suspending tubes from the furnace ceiling.

Fig. 16 shows the second flue of the boiler and illustrates the kind and arrangement of the tubes. At the bottom of the illustration is seen part of the auxiliary heating surface for effecting the control.

Fig. 17 shows a Benson boiler with corner firing, manufactured by Kohlenscheidungs-Gesellschaft. Six of these boilers are under construction for a large plant. Kohlenscheidungs-Gesellschaft mills are being provided for firing low-grade coal and also slime coal.

TYPES OF FIRING FOR BOILERS UNDER CONSTRUCTION

The following types of firing are being provided for the boilers now under construction: 24 with Kraemer mills; 19 with blast-type mills and corner firing (Kohlenscheidungs-Gesellschaft and Loesche); 10 with powdered-coal firing, corner firing, central mill system; 1 with traveling-grate stoker; 3 with Martin underfeed stoker; oil firing for all marine boilers and boilers for testing purposes.

As has been mentioned before, the Benson boiler may be operated at any desired pressure and is of particular advantage at pressures above 570 lb per sq in. The boiler consisting only of comparatively small-size tubes, its cost is largely independent of the boiler pressure. German experience has shown that at 570 lb the prices of Benson boilers and normal drum-type boilers of equal rating are about the same. However, at 1400 lb, the price of the Benson boiler is lower by about 20 per cent. From this it is clear that the Benson boiler should receive consideration primarily for high-pressure installations, and it has been found that this type of boiler is suitable for practically all cases in which normal high-pressure, drum-type boilers have been considered for installation. Consideration must be given to the smaller storage capacity of the Benson boiler as compared to the normal boilers. However, this storage capacity is not

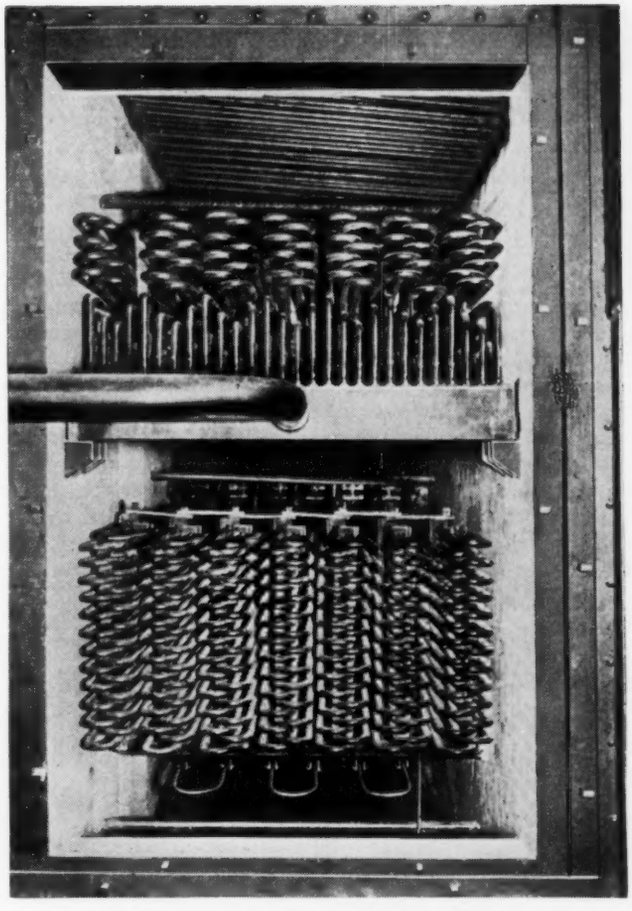


FIG. 16 BENSON BOILER IN S.S.W. CABLE WORKS
(Second flue with transition section, superheater, and part of auxiliary heating tube.)

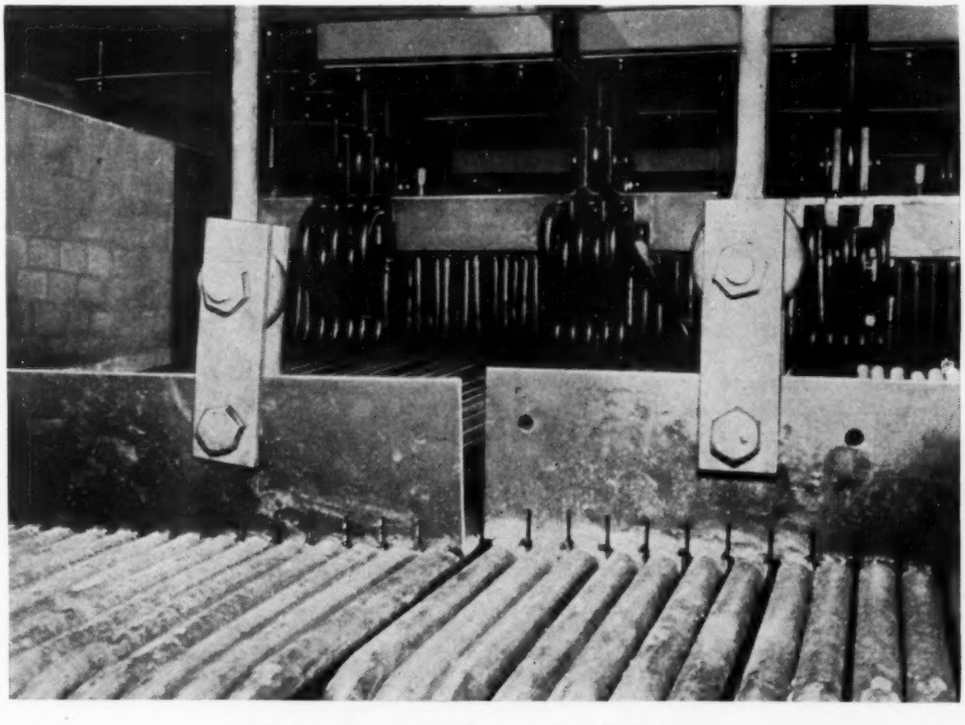


FIG. 15 BENSON BOILER IN S.S.W. CABLE WORKS
(Suspension of tubes from furnace ceiling.)

so small as is generally assumed. For example, a Benson boiler rated at 220,000 lb per hr and operating at a pressure of 1780 lb per sq in. can supply sudden load increases of 10 per cent above rated load for one minute at a pressure reduction of 10 per cent, or 178 lb per sq in. Therefore, in cases where sudden and large fluctuations of load are expected, a type of firing should be provided that can be controlled sufficiently fast by a regulation system.

VARIABLE PRESSURE SYSTEM OF OPERATION

The fact that a Benson boiler may be operated at different pressures permits in many cases employing the so-called variable-pressure system of operation. This method is based on the following principle:

If all regulating devices of a turbine are completely open, the steam pressure at the steam inlet will depend on the volume of steam flow. When steam flow increases, this pressure must also increase in order to force the required weight of steam through the turbine, and vice versa, for lower steam flow. Since the volume of steam changes in close inverse proportion to the steam pressure, the pressure at the steam inlet will also change in close proportion to the steam flow. Therefore, the turbine

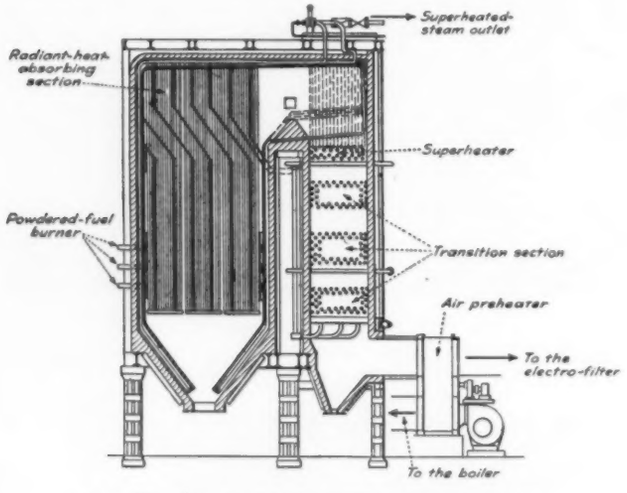


FIG. 17 BENSON BOILER WITH CORNER FIRING
(Maximum steam generation, 220,000 lb per hour; pressure, 1422 lb per sq in.; temperature, 932 F.)

operates under all loads with practically the same total volume and nearly constant steam-path efficiency. This is of particular importance in plants which are operating at times at low outputs.

Overloads need not be obtained by actuating an overload valve, but are accomplished by merely increasing steam pressure, which is automatically obtained as soon as the boiler supplies more steam. The advantages of the variable-pressure system in connection with the Benson boiler lie not only in simplifying operation, but also in that the steam temperature at the turbine can be held constant for all loads, whereas in other cases the temperature decreases under partial-load operation due to throttling the steam in the regulating devices. Furthermore, the power required by the feedwater pump decreases considerably under partial-load operation. The final result is a favorable steam or heat consumption.

A fundamental diagram of a simple back-pressure plant designed for variable-pressure operation is given in Fig. 18. It is assumed that the generator feeds into a power system, which can always absorb as much energy as the steam turbine is able to deliver in proportion to its steam flow, which depends solely upon the steam quantity required by the low-pressure or heating system. The turbine operates with regulating devices completely open. The speed regulator of the turbine is adjusted so that it becomes operative only when the normal speed is exceeded by some prearranged amount. The boilers are regulated in response to the pressure in the lower-pressure system. If necessary, heat exchangers with considerable storage may be provided. The Benson installation in the heating plant of the S.S.W. Cable Works is connected and operated as shown in Fig. 18, with the indicated pressures and temperatures applying to this installation.

This method of operation is also possible in plants with complete or partial condensing operation, as shown in Fig. 19.

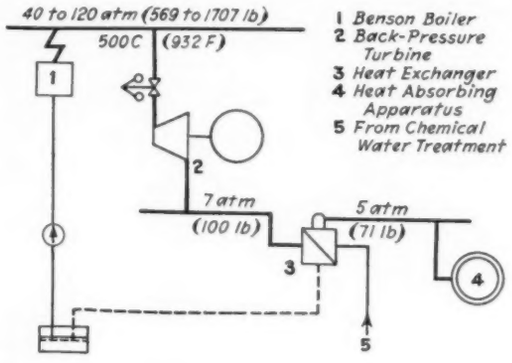

40 to 120 atm (569 to 1707 lb)
500C (932 F)
1 Benson Boiler
2 Back-Pressure Turbine
3 Heat Exchanger
4 Heat Absorbing Apparatus
5 From Chemical Water Treatment
7 atm (100 lb)
5 atm (71 lb)

FIG. 18 STEAM CONNECTIONS OF A BACK-PRESSURE PLANT WITH VARIABLE-PRESSURE SYSTEM OF OPERATION

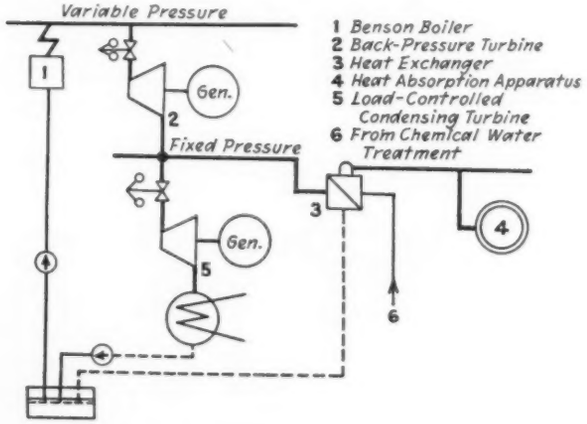


FIG. 19 STEAM CONNECTIONS OF AN EXTRACTION-CONDENSING PLANT WITH VARIABLE-PRESSURE SYSTEM OF OPERATION

In such plants, the frequency is controlled by the condensing turbine, while the high-pressure turbine utilizes all steam supplied by the boilers. In other words, load fluctuations in the electric system are first taken care of by the condensing turbine with the result that the intermediate pressure will show a tendency to change. This variation is used to regulate the boiler output either manually or automatically. This method is always applicable in plants operating in parallel with others, and not required to maintain the frequency of the system. In isolated plants or plants controlling frequency, however, the variable-pressure method can be used only if sufficient storage capacity is present in the intermediate-pressure system, such as provided by heat exchangers shown in Figs. 18 and 19. In purely condensing plants, storage capacity may be made available in low-pressure boilers or other steam-storage devices. The Langerbruegge Benson boiler installation operates in conjunction with low-pressure boilers. Operation on the basis of this scheme requires additional storage in form of heat exchangers

or low-pressure boilers for the reason that, with variable-pressure operation, storage capacity cannot easily be included in the high-pressure Benson boiler system, except by arranging for a reserve of pressure, as, for example, the author suggests, by a different system of boiler control in which a turbine governor controls an admission valve, which under constant operating conditions maintains a constant moderate pressure drop. Changes of the pressure drop provide the impulses for boiler control. On a decrease of load, or a complete loss of load, the effect would be as instantaneous as in a normal turbine installation, an increased pressure drop due to the valve's moving in a closing direction reduces feed supply and combustion. On an increase of load, the pressure drop over the valve would decrease, give immediately that much more pressure to the turbine, and provide the time and opportunity for increased combustion to become effective.

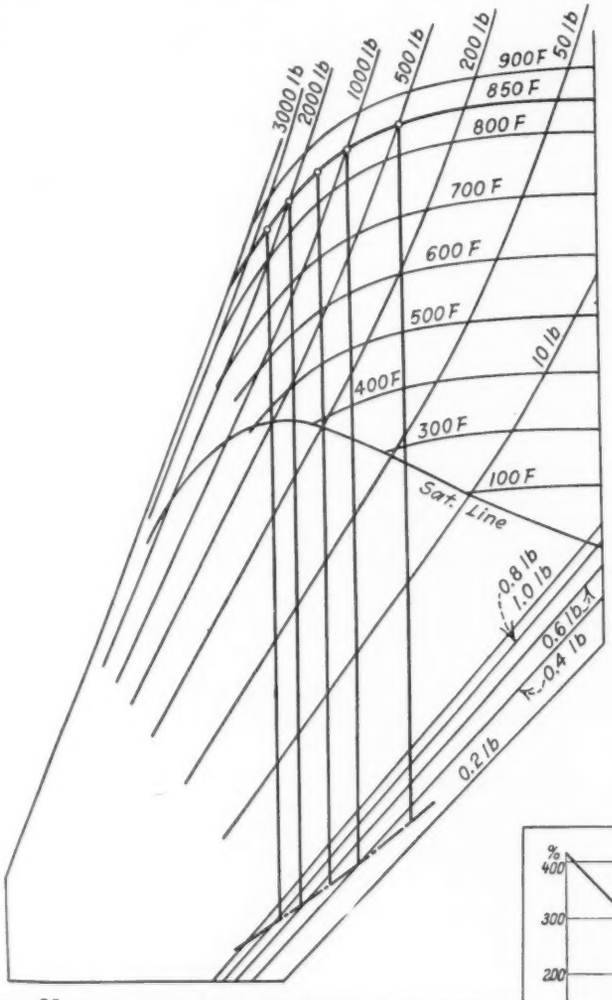


FIG. 20 ISENTROPIC HEAT DROPS OPERATING WITH VARIABLE PRESSURE

The author here desires to remark by way of discussion, not altogether in accord with the foregoing, that in the case of a complete condensing power system, whose sole purpose is the generation of power, the isentropic heat drop or the available work remains nearly constant, particularly if allowance is made for the condenser pressure properly varying with flow, as shown in Fig. 20. This is equally true if intermediate reheating is included. The economical performance would be expected to be slightly better at fractional loads with variable pressure than with constant maximum-pressure operation because the turbine steam path is more appropriate to the steam volumes.

In the case, however, of a plant comprising a turbine exhausting at constant pressure into a heating system, the economical performance of the plant at fractional loads is distinctly in favor of operation with constant maximum pressure, if the turbine is equipped with nozzle group control. For example, consider a plant arranged to operate at 1200 lb per sq in. (abs) at full flow and at a constant temperature of 900 F, and turbine exhaust delivered to the heating system at a constant pressure of 100 lb per sq in. (abs), in which it is condensed and returned at a pressure and saturation temperature corresponding to the atmosphere. With an appropriate nozzle group which operates at full pressure with one-half flow, and with allowance for a lower steam-path efficiency when operating with constant maximum pressure and for the difference in the work of the feed pump, then at one-half flow about 20 per cent more turbine output per unit of heat supplied is obtained, with only about 3.5

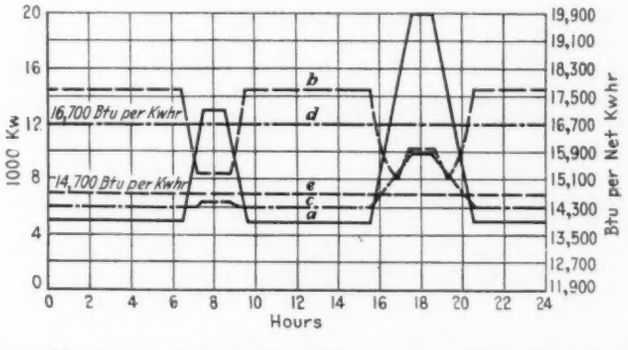
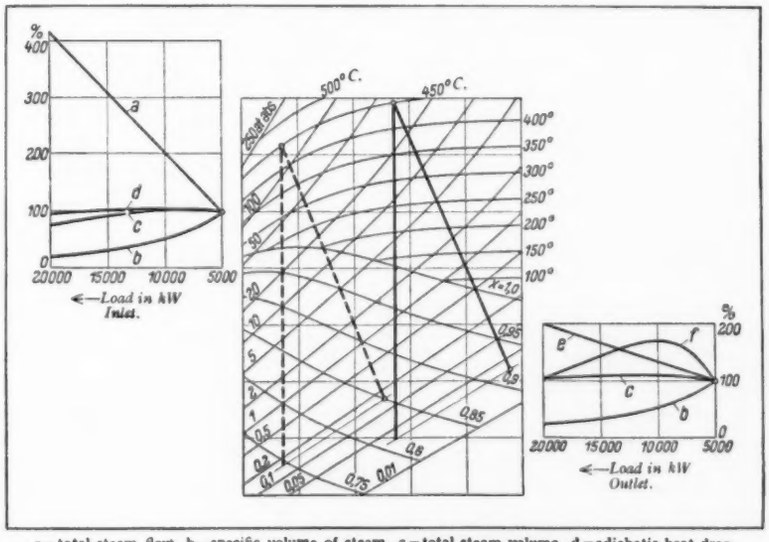


FIG. 21 PEAK-LOAD STATION WITH VARIABLE-PRESSURE SYSTEM OF OPERATION

(Load and heat-consumption diagrams for variable-pressure and constant-pressure operation. *a*, load; *b*, heat consumption at constant pressure, 355 lb per sq in., 743 F; *c*, heat consumption at variable pressure without reheating; *d*, average heat consumption at constant pressure; *e*, average heat consumption at variable pressure without reheating.)



a=total steam flow, b=specific volume of steam, c=total steam volume, d=adiabatic heat drop, e=final moisture, f=exit losses.

FIG. 22 MOLLIER DIAGRAM FOR A PEAK-LOAD STATION WITH VARIABLE-PRESSURE SYSTEM OF OPERATION WITHOUT REHEATING

per cent less heat supplied to the heating system, as compared with operation at variable pressure.

In the case of a system to generate power, in which a back-pressure turbine operates in conjunction with low-pressure boilers and condensing turbines, and in which the exhaust steam from the turbine is reheated, its pressure being maintained constant, the economical performance of the plant is in favor of operation with constant maximum pressure, to a less degree, however, than in the case of the previous example, the difference being due to a difference in the work of the reheater.

For example, consider a plant arranged to operate at 2000 lb per sq in. (abs) at full flow, and at a constant temperature of 900 F, and high-pressure turbine elements exhausting steam at a constant pressure of 300 lb per sq in. (abs) which is reheated to 850 F and led to the low-pressure condensing turbines. Again with a nozzle group appropriate for one-half flow with full pressure, and with similar allowances for difference in the efficiency of the steam path, and for the work of the feed pump, the economical performance of the plant would be about 4 per cent better per unit of heat supplied when operation is at constant maximum pressure as compared with operation with variable pressure. It is desirable when possible, therefore, to allocate certain turbines to operate always with the superposed turbine, so that the pressure to the low-pressure turbines may

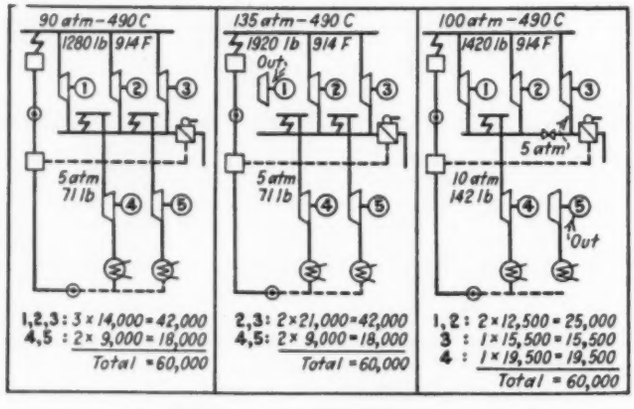


FIG. 23 60,000-KW EXTRACTION-CONDENSING PLANT

(Maintaining full load by increasing pressure in high-pressure or low-pressure system without appreciable increase of heat consumption.)

also vary with load, when the full value of the variable-pressure method is realized.

In the foregoing examples no consideration has been given to regenerative feed heating by extraction.

All this, however, does not detract from the convenience and simplicity of operation with variable pressure, particularly in so far as the turbine is concerned. On the other hand, the Benson boiler can as easily be arranged to operate with constant pressure.

A valuable feature of variable-pressure operation has been communicated which will result in low-cost design for peak-load plants which do not control frequency, but operate on a load schedule. The design can be made such that base load as well as load peaks may be supplied at comparatively favorable steam consumption. Assuming, as is shown in Fig. 21, a plant with a base load of 5000 kw or a multiple of this value, and a maximum peak of 20,000 kw or a multiple thereof, the operation will result in conditions as shown in Fig. 22. If the pressure at the base load is taken as about 35 atm (500 lb per sq in.) at 450 C (842 F), the peak-load conditions will be 140 atm (1990 lb per sq in.) at the same temperature. This would not be possible without reheating if good vacuum were maintained. If, however, the condenser is designed so that it is appropriately dimensioned for 5000 kw, its vacuum will be correspondingly impaired at 20,000 kw, and for equal steam temperature an inconsiderable increase of the moisture in the steam will be obtained. If the steam temperature is increased for the peak load, as is quite possible with a Benson boiler, the moisture in the steam may be maintained at the same value as at 35 atm (500 lb per sq in.).

In plants which are not suitable for the variable-pressure method of operation, the ability of the Benson boiler to operate at different pressures can also be used to advantage. For example, in the case of a back-pressure plant with several turbines the generators may be overdimensioned somewhat and the turbines may be designed so that they can withstand a somewhat higher pressure, with the result that when one turbine is put out of commission, full output of the plant can be maintained if only the pressure is correspondingly increased. An example of pressure and load conditions obtaining during such operation is given in Fig. 23.

ADVANTAGES SUMMARIZED

The advantages of the Benson boiler may be summarized as follows:

(1) Minimum weight and minimum dimensions, therefore all investment.

(2) No boiler drums.

(3) Forced circulation, therefore elimination of all difficulties resulting from gravity circulation in other boilers, which become greater with higher pressures. Consequently, also considerable reduction of corrosion.

(4) Constant, but adjustable, steam temperature under all loads.

(5) Great overload capacity, limited only by characteristics of firing and accessories.

(6) The Benson boiler may be operated at any desired pressure. Particularly advantageous is the variable-pressure method of operation.

(7) Feedwater pump is the only pump used, and no additional steam or water pumps are required.

(8) No leakages, even under frequent and quick starting and shutting down, due to welding of all tubes.

(9) Owing to the small diameter of tubes, tube defects—if they should occur—are of no serious consequence, while bursts in normal drum-type boilers always greatly endanger the equipment and operating personnel. Therefore, the Benson boiler is an absolutely safe boiler. As a result, in Germany, boilers may be installed within and even above rooms frequently occupied by persons.

(10) Overhauling is easy and fast, since heating surfaces are only welded.

(11) The feedwater-pump reserve may be considerably smaller than with other boilers. In Germany, regulations require for normal boilers the installation of two entirely independent pumping plants, each with a capacity of double the boiler rating. For Benson boilers, however, regulations require two pumps, each with a capacity equal to the boiler rating. This reserve can be further reduced in large plants. For example, in a large plant now under construction, and with an installation of six boilers, only eight pumps are being provided, each of which is dimensioned equal to the capacity of a boiler.

BENOÎT FOURNEYRON (1802-1867)

Civil Engineer of Mines, Chevalier of the Legion of Honor, Consulting Industrial Engineer, Representative of the People in the Constituent Assembly, Patriot, and Pioneer in the Scientific Development of the Hydraulic Turbine

By FREDERIC W. KEATOR

YALE SCHOOL OF ENGINEERING, NEW HAVEN, CONN.

ALMOST every work on hydraulic machinery mentions the name of Fourneyron as a pioneer in hydraulic-turbine design and construction. But beyond the mention of his name and the date, 1827, when his work first came to the public notice, there is practically nothing describing his life or work. He is not included in the Americana or Britannica encyclopedia nor in any of the standard biographical references. This strange paucity of information, relative to a person of such apparent importance, constituted a challenge which could not be ignored.

It was a fairly easy task to find several bibliographies of Fourneyron's writings but biographical information was more elusive. While looking through one of the bibliographies, a note, in fine print near the bottom of the page, was found which referred to a biographical article, by Jules Guellemin, published in the *Bulletin de la Société Industrielle de Mülhausen*, volume for 1868. This article proved to be a perfect gold mine.

Jules Guellemin was a close friend and colleague of Fourneyron and his biographical sketch was written only a few months after Fourneyron's death and, allowing for the efflorescent style of the French, it gives an excellent account of the man and his work. A second source was found in the *Bulletin de la Société des Ingénieurs Civils de France*, for June, 1927, which contains an account of the celebration of the centenary of Fourneyron's turbine.

BENOIT FOURNEYRON IN 1840 AT THE AGE OF 38

Also included are two discourses, one by G. Koenigs on Fourneyron's life and the other, by A. Rateau, on his work. It is quite apparent that the material for Koenigs' article was drawn, almost exclusively, from the Guellemin paper. Rateau, on the other hand, obtained his material from Fourneyron's published works, the bibliography of which is very complete and easily obtained. In view of these facts, the writer has gone to the original sources for the material upon which this article is based.

Benoit Fourneyron was born November 1, 1802, at Saint-Étienne (Loire). His father, Jean Fourneyron, was a land surveyor of some prominence, who had rendered valuable service in the coal mines of the district. His mother was Catherine Sayve and both parents were descended from well-to-do landed farming families of the Loire region. At the time of their marriage, his parents had acquired and established themselves in an estate known as "La Cible" (The Target) in Place Chavanelle, Saint-Étienne. The name, according to local legend, was given to the estate in commemoration of the time when it served as the meeting place for the archers of Saint-Étienne. It was here that Benoit, his brother Jean-Claude, and two sisters, Anne Marie and Eulalie, were born. Neither of the boys ever married. Both of the girls were later married but the younger, Eulalie, who was espoused to Francis Crozet, was the only one to have issue. The children of Crozet, in order to perpetuate the name of their illustrious uncle, later joined his name with theirs so that the family name is today Crozet-Fourneyron.

Benoit began his studies of mathematics at an early age under the tutelage of his father who made him his assistant in the surveying work. Thus he learned his geometry in a practical way with chain and compass. When he was nine years old he entered the College of Saint-Étienne where he presently showed himself to be a student of exceptional promise. He studied both French and Latin but his natural aptitude leaned toward the mathematical sciences. Nevertheless he was the ranking scholar of his class in all branches of the curriculum.

An ordinance of 1816 created a School of Mines which was to replace that of Kaiserslautern which was located in a region lost to France under the late treaties. The new school was located at Saint-Étienne which was, and still is, the center of a large mining and industrial region of the Loire.

Fourneyron's teachers, at the College of Saint-Étienne, who had followed his progress with interest and appreciated his intellectual and moral qualities, advised him to apply for ad-

mission to the new school of mines. The fact that Fourneyron was barely fifteen years old, at the time, was a serious barrier to be overcome. However, the professor of mathematics, struck by the brilliant promise manifested by Fourneyron in his entrance examination, took it upon himself to obtain a dispensation of the age requirement from the Director General of Bridges, Roads, and Mines. The request was granted and on the 15th of October, 1817, Fourneyron entered the new school as a student in full standing.

Among his classmates was Jean-Baptiste Bousingault, the future great chemist and member of the Economic Section of the Academy of Science. They became friends almost at once and this warm friendship lasted the rest of their lives. These two were easily the ranking scholars of the school and, in 1910, at the dedication of a new building for the school, their names were engraved together upon the facade.

The first director of the school was Baunier who seems to have taken a lively interest in the careers of his students. He placed great confidence in the evident promise exhibited by the young Fourneyron. Upon graduating from the school, August 15, 1819, Fourneyron was given a series of important commissions to execute; a sort of apprenticeship training. Although he was less than seventeen years old, Baunier did not hesitate to appoint him manager of the mines at Creusot. He was engaged on this work for a period of about one year and then was recalled to Saint-Étienne where Baunier had further plans for his career.

In 1820, France found herself, after a long series of wars, in a rather favorable relationship with foreign countries, notably England, where the iron industry and manufacturing had made great progress and where railroads were beginning to be organized. It was necessary that France take steps to place herself on a level with this progress. So far as metallurgy was concerned, France had some simple puddling furnaces, burning charcoal, and a few old-fashioned wood-burning furnaces. De Gallois had tried to introduce the treatment of iron carbonate with coal, a process which had gained some success in England, since the ore existed there, and it was suspected that it existed in the French basins.

The next task given Fourneyron by Baunier was a search for iron carbonate, in commercial quantities, and an examination into the possibilities of creating a large ironworks to use this ore. Fourneyron entered upon this task with enthusiasm and the report of his findings was so complete and detailed as to leave no doubt concerning the possibility of establishing ironworks in the Loire region on a sound basis. The development of metallurgical plants in the basin of d'Alais au Vigan were a direct result of Fourneyron's report.

In 1821 Fourneyron, in company with a classmate, Achille Thirion, was charged with the study and mapping-out of a project for the first French railroad which was intended to connect the coal-mining district, of Saint-Étienne, with the Loire at Andrezieux. Thirion later became a member of the board of directors of this same railroad.

Toward the end of 1821, a leasing company, who was operating the ironworks belonging to the Portales family, where the furnaces burned charcoal as a fuel, wished to experiment with coal. Having heard of his work with de Gallois and Baunier, they employed Fourneyron to direct their works. In the course of this employment he gained considerable success in the making of white cast iron; an industry little advanced in France and which the English cloaked in great mystery. It will be recalled that white cast iron is the primary step in the making of malleable cast iron. It was here, at Pont-sur-l'Ognon, that he initiated some of the first experiments on the strength of materials with particular reference to the properties of cast iron. The results of his findings were the subject of a memoir sent to l'École de Saint-Étienne in 1822. He also erected a rolling mill for sheet iron, in this plant, which was driven by a water wheel. This installation was put into operation in December of 1822 and was so successful that the company doubled his salary.

It may be said that this experience marked the beginning of his interest in hydraulic motors which led to his profound studies of them. He set himself to master the works of Euler, Borda, Bernoulli, Navier, and his own professor, Burdin. He, himself, made some notable contributions in simplifying and correlating the theories of these savants.

At the time Fourneyron undertook his studies of hydraulics practically all the water wheels in use were either overshot or breast wheels; the former being by far the most numerous. The overshot wheels had a diameter sensibly equal to the available head and, when well constructed, attained an efficiency of from 60 to 70 per cent. On the other hand, they had some serious faults; they could not be run with any part of the wheel submerged so that, in times of flood in the rivers, the wheels had to be shut down, involving financial losses to owners and workers alike. To overcome this difficulty they were sometimes made smaller and placed at some distance above tail water. This method, however, sacrificed a part of the available head.

A few small wheels, with vertical shafts, existed in the south of France, in Spain, and Italy. These wheels, which Burdin called turbines, rarely attained an efficiency greater than 25 or 30 per cent. No very great improvements had been made in the primitive design in spite of the fact that such able men as Euler, Borda, Navier, and Burdin had devoted some attention to them. These scholars, commencing with Euler about 1754, had laid the foundation of the theory which was notably improved by Burdin, about 1820. Borda and Burdin both realized that the ideal turbine required the water to enter the wheel without shock and to leave without velocity. Borda built several turbines; one, built according to the precepts conceived by Euler and installed at Pont-Gibaud, attained an efficiency of 67 per cent though there is some doubt as to the accuracy of the measurement of the outflowing water. Burdin also designed a turbine but his design was not entirely practical from a builder's standpoint although the machine ran well enough. Its efficiency, however, was only about 65 per cent. Something more than theory was needed to develop a practical machine; an intuitive comprehension of the details of construction was required. It was this precious gift which Fourneyron possessed and which allowed him to do more than the most powerful theorist had done thus far.

In 1824 Fourneyron's work was tragically interrupted by the death of his mother followed very shortly by that of his father. At twenty-two years of age he found himself the head of a family with a younger brother and two younger sisters to care for. He refused his father's will, which suggested the appointment of a guardian for the younger children. In the course of a few months he cleared the complicated affairs of the family estate; sent his sisters to the best boarding school he could find; left his brother, then a student at l'École des Mines, in charge of the family home; and returned to his work at Pont-sur-l'Ognon. However, on arriving there, he discovered that the leasing company, which had employed him, had been replaced by a corporation which was not sympathetic with his work or researches, but, in spite of this handicap, he carried on as best he could. His contract with his original employer had stipulated that he should have the use of the waterfall for his turbine experiments for the period of one month in each year. By enforcing this clause with the new company, he was able to keep on with his work.

Certain of his friends suggested a change of employment but

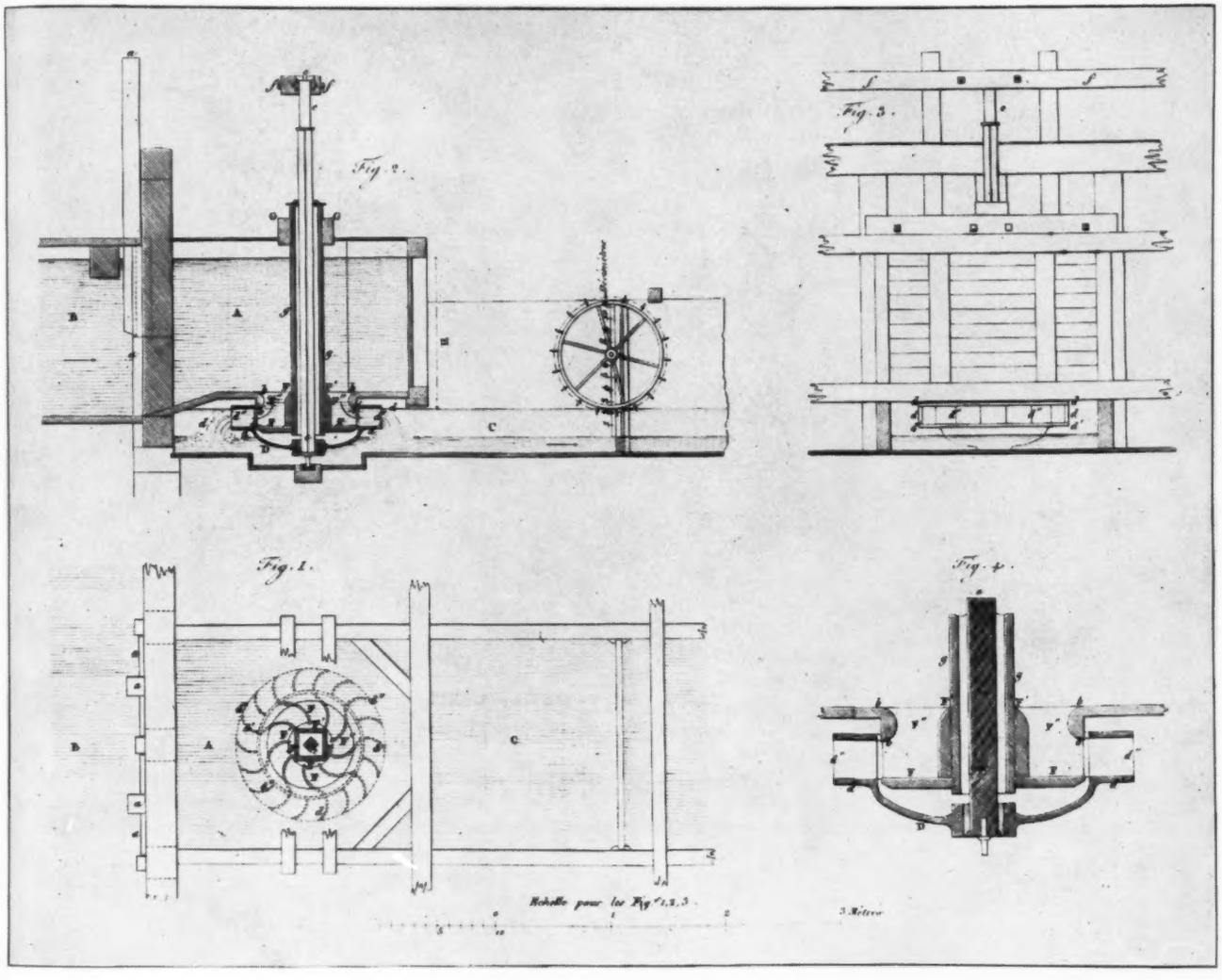


FIG. 1 EXPERIMENTAL TURBINE AT PONT-SUR-L'OGNON

Fourneyron did not wish to give up the facilities, for his experiments, which he found at Pont-sur-l'Ognon. However, the new corporation, having thrown overboard Fourneyron's economical methods in the plant, found that they were unable to make a go of it and closed the establishment in 1827. This event forced Fourneyron to make a change and he removed to Besançon where he set up a consulting practice and, it may be said, that this marked the real beginning of his career as an engineer.

CAREER AS AN ENGINEER

His consulting practice widened rapidly and soon included a surprising variety of industries. Among his clients were the Koechlins, Dolfus, Schlumberger, and Dietrich, all well-known firm names in the district. To illustrate the wide scope which his work assumed, the following partial list of the industries, which sought his advice, is given:

Blast furnaces
Ironworks
Rolling mills
Machine forging
Coal-mining machinery
Mine drainage pumps
Spinning machinery for both cotton and flax
Looms and weaving machinery
Printing presses
Bleacheries
Flour mills
Paper mills
Fabricating plants
Blowing engines
Cutlery works
Saw mills
Fulling mills

In all about one hundred twenty-nine establishments. Later he also built a plant of his own for mechanical construction at Chambon-Feugerolles. The machine shop was equipped with the best and finest machines of the time and the foundry could produce castings of considerable weight. He placed his nephews, Jean-Claude and Emile Crozet, graduates of the Central School of Arts and Manufactures, in charge of this plant. He also installed a hydraulic laboratory in this plant so that he might continue his work on the turbines.

Fourneyron spent four years, at Pont-sur-l'Ognon, in experimental study of his turbine before he announced his results. Among other things, he had need of a dynamometer with which to measure the output of his wheels. The prony brake had been invented some years previously but it had not attained any success; largely because of lack of skill on the part of those who attempted to use it. In the hands of Fourneyron it gave excellent results. He made the brake the subject of the first of his scientific papers to be published. The paper was presented in competition for a prize offered by the Société Industrielle de Mülhausen in 1827. The prize was bestowed on Fourneyron in 1828 and the society also bestowed a prize on de Prony for his invention of the brake, which had been unrecognized until that time

In 1826, the Council of the Société d'Encouragement pour l'Industrie Nationale proposed an important prize, of six thousand francs, for a full-scale application of hydraulic turbines for

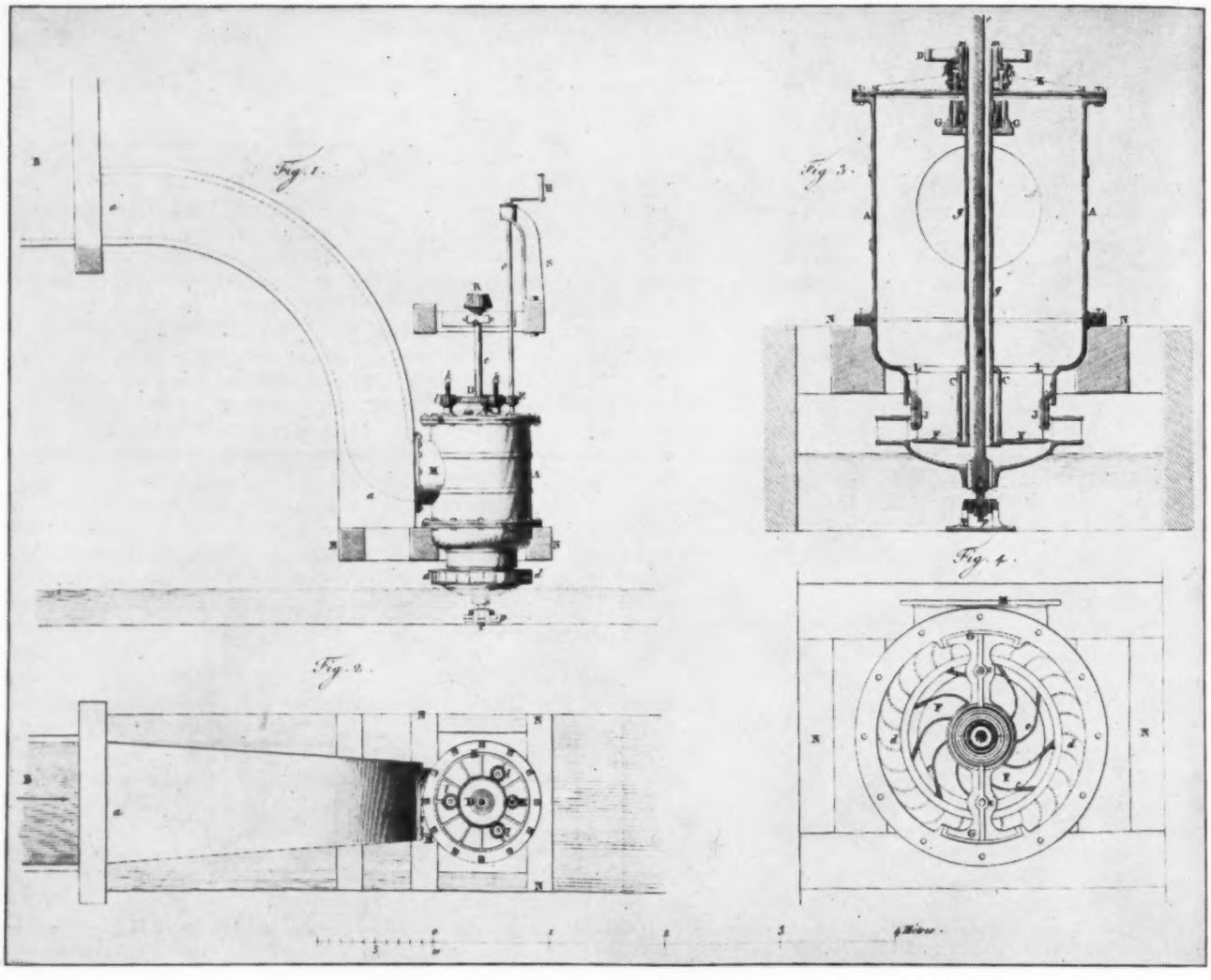


FIG. 2 DAMPIERRE TURBINE WITH CONTROL GATE

industrial power purposes. Of the four contestants, who submitted papers in the competition, Fourneyron, who presented a very complete theoretical and descriptive memoir on three turbines of his own design, was adjudged the winner and the prize was awarded to him December 24, 1833. His memoir was published in the bulletin of the society in 1834. It described the turbines installed at Pont-sur-l'Ognon, Dampierre, and Fraisans and all three attained an efficiency of better than 80 per cent. The memoir also contained, in part one, a complete discussion of the theory upon which his design was based.

At this point it might be well to examine some of the features of these machines. The experimental turbine, at Pont-sur-l'Ognon, Fig. 1, was designed for a head of 1.4 m (4.59 ft). It had no casing but was installed directly in the bottom of the flume, and developed about 6 chevaux[1] at 60 rpm. The test results of this machine were not entirely concordant, nevertheless, it seems correct that the efficiency reached 83 per cent with the machine running unsubmerged. The efficiency was not materially changed when the machine was submerged to a depth of 25 cm but it was reduced about 6 per cent when the submergence reached 50 cm. This machine was an outflow type with total admission as were all of Fourneyron's turbines. Some writers, in describing Fourneyron's turbines, have made the mistake of assuming that they were reaction turbines, meaning pressure-type turbines. The maximum efficiency of the Pont-sur-l'Ognon turbine corresponded to a relative speed[2] of 0.42 which indicates that the machine was functioning as an impulse or pressureless turbine. Another proof of this fact is more easily seen in the Dampierre and Fraisans turbines where the gate construction is such that the wheel could not run full except at full gate. In the Pont-sur-l'Ognon turbine, the gap between the guide vanes and the runner was about two centimeters, almost an inch, which would hardly allow it to function as a pressure-type turbine.

The Dampierre turbine, Fig. 2, designed to operate under a variable head of from 3 to 6 m (9.84 to 19.68 ft), was similar to the experimental machine in regard to the distributor and the rotor, each of which was cast in one piece. However, several improvements appear in this machine; the cast-iron casing, the penstock also of metal, and the control gate. The control gate was cylindrical and was placed between the distributor and the rotor. It was raised and lowered by means of three screws which were geared to a central shaft turned by hand; automatic governing was not possible at this time because governors were not powerful enough to act directly and the servomotor had not been invented.

The Fraisans turbine resembled the other two except that it

[1] 1 cheval = 0.9863 hp = 542.3 ft-lb per min.

[2] Relative speed is the ratio of peripheral velocity to water velocity = u/v.

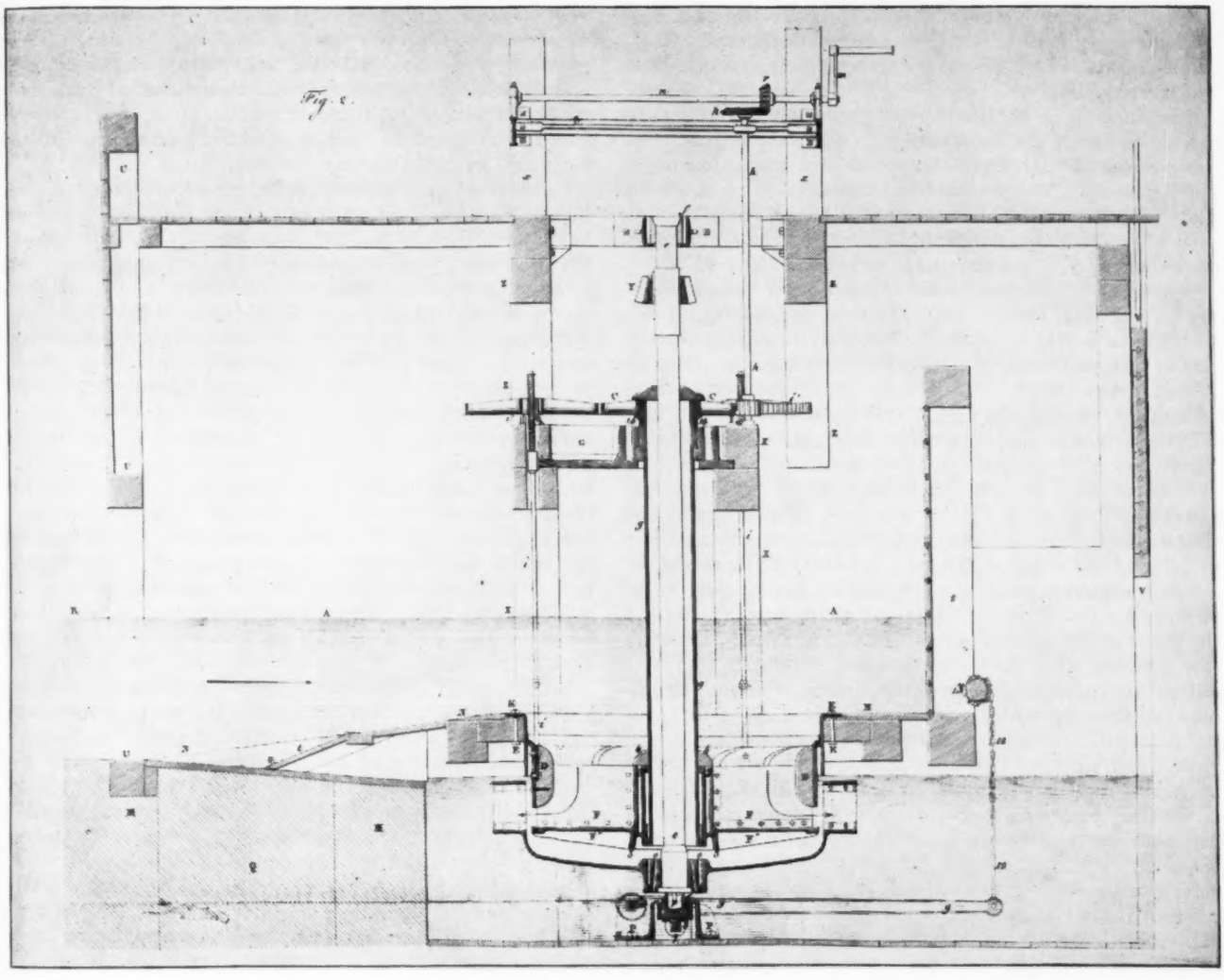


FIG. 3 FRAISANS TURBINE

was constructed of iron plates because of its great size; the diameter was 2.4 m (7.87 ft). It was designed to operate under a head of 1.3 m (4.26 ft) and was equipped with essentially the same type of regulating gate as the Dampierre machine. This turbine had one innovation—a means of regulating the height of the lower pivot bearing. See Fig. 3. Fourneyron built this machine of plate because so large a casting was beyond the capacity of the foundries at his disposal and he feared that a sound casting could not be produced.

In all of these machines there was an imperfection in the curvature of the blading and in the entrance angles. For the water to enter without shock, the blades should not be normal to the inner circle, as can be seen in all three drawings, but should have a more acute angle. Fortunately it is not a serious fault because the shock loss, at entrance, does not increase rapidly with shock angle. Fourneyron probably never investigated the effect of shock angle; he was satisfied with the results he had obtained and adhered to his original blade shape in all of his later machines.

In the course of his career, from 1832 to 1867, Fourneyron built and installed more than one hundred turbines in France, and other parts of Europe. A few of his machines were used in the United States; the earliest being built about 1843, some six years before James B. Francis built his first inward-flow turbine. At least one of Fourneyron's turbines was sent to Mexico. This particular installation involved some difficult problems because the machine had to be transported over mountainous terrain. This required the turbine to be constructed so that the individual parts were small enough to be carried on the backs of mules. Nearly all of the turbines were built in the shops of Andre Koechlin at Mulhouse, Dietrich at Niederbronn, or in his own plant at Chambon-Fuegerolles (Loire).

Among the later machines were two which were most outstanding because they represented an audacious departure from that which had been done before—utilizing high heads. These machines were installed at a spinning mill at Saint-Blaise (Black Forest) in 1837 and were designed to operate under heads of 108 m (354 ft) and 114 m (374 ft), respectively. These heads were far in excess of anything that had ever been attempted previously. Besides the difficulty of designing the turbines themselves, there were other seemingly insurmountable problems. It was found practically impossible to build a reservoir and canal; the latter would have been 2400 m long and would have had to follow the face of a cliff where it was impossible to transport men and materials. The only other alternative was to construct penstocks but the existing formulas for cast-iron pipes were inadequate for the pressures which would be encountered under these heads, and the use of wrought iron was even less understood. The penstocks were to be 500 m in length and the lower ends were required to withstand a pressure of about 160 psi. Fourneyron was not daunted; he constructed some test sections, according to his own designs, of

wrought-iron plates, which he tested to a pressure of 265 psi without any sign of failure. This demonstration swept aside all objections to his proposal and the complete penstocks were ordered accordingly.

The Saint-Blaise installation is a good example of Fourneyron's pioneering; the first use of high heads and penstocks for great pressures, high rotational speeds—these machines ran at approximately 2300 rpm—and the transmission of power by gears at high speed. The machines developed about 60 chevaux each at an efficiency of slightly over 80 per cent. The rotors were about 12.5 in. in diameter and weighed less than 40 lb.

Apparently the largest turbines, which were built to Fourneyron's designs, were two of 220 chevaux each installed in a large textile mill at Augsbourg. There is no complete description of these machines but it is known that they operated under a head of 5 m (16.4 ft) and that the power was used to drive some 30,000 spindles and 800 looms in the factory.

Fourneyron was also responsible for beginnings in several of the accessories to the turbine. In an addition to his patent of 1855 he wrote: "The absolute velocity which remains in the water after its action in the wheel is rarely nil and sometimes is considerable. Thus all the active force, represented by the velocity of the water at exit, is a pure loss. The means, by which I propose to avoid this loss, consists of enlarging, by insensible degrees, the cross section of the passages conducting the water to the tailrace, so that the extreme section is twice, thrice, or four times the first section. By this means the water will be stripped, by the shape of the passage, of all the velocity over and above that needed to barely flow out. Thus an artificial head will be created, greater than the natural head . . . . provided that it does not exceed the column of water which represents the atmospheric pressure." It is from this improvement, initiated by Fourneyron, that we have developed our present-day draft tubes, diffusion plates, hydrocones, and divergent volutes.

He also devised a scheme of introducing several stages into a turbine in order to reduce rotational speeds on high heads. He built several of these with two, three, and even four stages. In order to avoid the use of large casings and rotors on the lower heads, he designed machines with two or more rotors on the same shaft which he called "géminée" (twinned) or "bigéminée" (double-twinned), respectively. As a general name for this class of machine, he coined the word "pleodynamique." He devised schemes for lubricating the lower bearings of his machines which were novel and effective.

Two of Fourneyron's most magnificent projects were never undertaken: (1) a project to utilize the power of the Rhine, in Alsace, and (2) a similar project for the Seine at Paris. The former, studied and worked out in collaboration with Émile Koechlin, was made the subject of a communication to the Academy of Science on December 11, 1837. This project proposed to use the power of the Rhine, at Huningue, by means of a canal 40 m wide, 4 m deep, and 130 km (approximately 81 miles) in length, extending to the environs of Strassbourg after having traversed most of the manufacturing towns of Alsace. The total drop of 104 m was to be divided into 30 separate falls so distributed along the length of the canal as to create a total power of some 40,000 chevaux for the benefit of industry.

The other great project, at Paris, was studied by Fourneyron in company with Arago during a part of 1835. After further study, they made a proposal, in 1844, to the Municipal Council of Paris, to build a large central pumping station at a point on the Ile de Cité. This plant was to have six turbines, of 800 chevaux each, driving pumps with a capacity of 300,000 cu m of water per day against a head of 45 m.

One interesting feature of this project was the ingenious gate design, which Fourneyron devised, to close the arches of the Pont-Neuf and thus create a head of a little over one meter which was to supply the power to the pumping station. These gates were articulated and were designed so that they could be opened or closed against the force of the current with little effort. When opened, they left the clear space of the arch free from any constriction. Similar gates had been built in Holland but these were a distinct improvement.

By 1838 his consulting practice had grown to such proportions that he moved to Paris in order to be more centrally located and he remained there for the rest of his life. At the Exposition of Paris, in 1839, he exhibited one of his turbines which was awarded the grand gold medal by the jury of award and Fourneyron received the decoration of the Legion of Honor.

Fourneyron had always aspired to membership in the Academy of Science and, in 1843, he presented himself as a candidate, in the mechanical class, for the vacancy left by the death of M. Coriolis. There were four other candidates for this vacancy, but the balloting, at the meeting of December 18, 1843, quickly narrowed to the choice between Fourneyron and Morin. The latter was finally elected and the opinion seems to be that Fourneyron lost "because he was not a polytechnician," though, in the light of modern ideas, this seems ridiculous. He never presented himself again as a candidate for membership in the Académy of Science but, in 1846, he was elected a corresponding member of the Boston Academy of Science. This honor came as a complete surprise to him and he was very proud of this recognition from across the seas.

In view of the success attained by his turbines, it is not surprising that there were many imitators and many infringements on his patents. Usually these machines were of inferior quality and he fought many a legal battle with these "pirates of industry," as he called them. In every case he emerged victorious although, at times, he was obliged to use every resource at his command to prove the infringement.

It was during his study of the Paris water-supply project that he evolved the idea of the "géminée" and "bigéminée" turbines, which have been mentioned previously. He had been somewhat afraid of the constructional difficulties attendant upon the building of machines of such great diameter and weight, as would be required for these 800-chevaux turbines under the low head of one meter. It was in seeking a remedy for this difficulty that he thought of the new principle which concentrated the power of several ordinary turbines in the one machine. He exhibited his pleodynamique turbine at the exposition of 1855 and was awarded the gold medal for the second time.

At the Universal Exposition in Paris in 1867 he exhibited two machines built at his own plant at Chambon-Fuegerolles. These were (1) a turbine with balanced gates, for easy regulation, equipped with a draft tube and (2) a single-cylinder pump fitted with two pistons and special valves arranged to give continuous flow without shock. In view of his many accomplishments, it is almost certain that, had he lived, he would have been awarded the cross of an officer of the Legion of Honor.

In all of his engineering career, Fourneyron was essentially an observer and an experimenter. He never installed a machine without first being assured of its satisfactory performance which he proved by repeated tests. As each successive machine was produced, in it were incorporated the fruits of his recent studies and experiments. Also, it usually embodied some novel means of overcoming an earlier difficulty. The number of experiments which he made was enormous and embraced a wide field of activity, including strengths and properties of materials, practically all branches of hydraulics and fluid flow, steam boilers and engines, and textile machinery, not to mention his earlier mineralogical and metallurgical work. His untimely death did not leave him time in which to coordinate and publish the results of the greater part of his work nor the formulas which

he had developed. The only record which we have today is contained in the few scientific papers and memoirs which he presented before various learned societies. Perhaps it is for this reason that his work is not better known to engineers generally.

CAREER AS A PUBLIC SERVANT

Fourneyron was a genial and kindly person, if we are to believe Jules Guellemin, his friend and confidant, possessing rare good judgment and quite liberal in his philosophy of life. He had a natural aptitude for his chosen work which was augmented by as good and logical an education as was available at the time. He left many proofs of his patriotism and zeal for the public welfare.

Established at Paris he became a member of the National Guard, joining a company of the Second Legion. Eight years later he was made captain of this same company and, one year afterward, was promoted to chief of battalion, which rank he held until after the revolution of February, 1848 when he took his seat in the Constituent Assembly. He was elected to this office from his own district, the Department of the Loire, receiving 41,833 votes. He served in the assembly until the end of 1849, when he was honorably defeated by another candidate.

In 1846, the mayors of several arrondissements of Paris were asked to make a choice, on behalf of the Minister of the Interior, of twelve candidates for election or appointment to various commissions. Fourneyron was among the twelve chosen and served on several important commissions, namely, administrator of the treasury of Paris, commissioner for the revision of customs-duty valuations, advisory commissioner of purchases and stores for the service of clothing supply of the army, and several others of lesser importance.

When the Committees on Public Health were created in each of the mayoralities of Paris, Fourneyron was named as a member of the Committee for the Second Arrondissement. In 1856, an underground flood had inundated the cellars and subsoil of certain parts of Paris creating a grave danger to the life and health of the populace. The committees of the two arrondissements, most seriously affected, charged three of their members, G. Halphen, Vaufflart, and Fourneyron, with the task of discovering and reporting on the cause of this inundation and, if possible, to suggest an immediate remedy. The cause of the trouble was speedily found and the remedy was indicated in the final report of the subcommittee. Incidentally, the report was so complete and detailed that the Committee on Public Health voted to have it printed at the public expense.

From what has been said it may be surmised that Fourneyron was a frequent exhibitor at the various expositions. He also fulfilled other functions at these affairs. In 1861 he was named a member of the jury of admission for the Department of the Seine at the exposition of 1862 at London. In 1866 he was again named for the jury of admission for the Universal Exposition of 1867 and later was designated, by the Imperial Commission, as a member of the international jury of award for the products of class 52 group VI (machines and apparatus of general mechanics).

Fourneyron finally succumbed to a disease which is described as "an enfeeblement of the functions of the stomach," probably cancer of the stomach, which caused him great pain. It is a tribute to the man when we read that "he always hid his pain under a brightness of spirit and an extreme kindliness which set an example to all of his colleagues."

A month before his death he dictated the terms of his last will and testament with perfect calmness and in full command of his faculties. The nature of his bequests is an eloquent proof of his friendliness and sterling virtue. After a just division, of a part of his rather large estate, among the members of his immediate family, he made a number of important bequests; to the Academy of Science, a sum of ten thousand francs the income of which was to be used every two years as a prize for the best paper or memoir on applied mechanics. It is interesting to note that, in 1924, this prize was won by Marcel Crozet-Fourneyron, grand nephew of Benoit Fourneyron. There were two other bequests, of five thousand francs each, to the Société des Ingénieurs Civils and to the Société Industrielle de Mülhausen. Another gift of ten thousand francs went to the Société de Secours des Amis des Science, which had been founded by Baron Thenard.

On July 8, 1867, Fourneyron died; the victim of a cruel malady which slowly sapped his strength. He left the heritage of an active life of usefulness to his profession and his fellowman.

In closing his address, on the occasion of the centenary of Fourneyron's work on the hydraulic turbine, Rateau said, "One could, in effect, establish a parallel between these two great men (Watt and Fourneyron). They had many points in common and we have signalized several in passing. If Fourneyron had been English, he would have been honored, without doubt, as the equal of Watt. We venerate his memory profoundly and join with Poncelet in giving him the title of 'Watt of Hydraulics.'"

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THE MELVILLE MEDAL

A.S.M.E. HONORS AND AWARDS

VI—The Melville Medal

GEORGE WALLACE MELVILLE, rear admiral, engineer in chief, and chief of the Bureau of Steam Engineering of the U. S. Navy, was elected to membership in The American Society of Mechanical Engineers in 1893 and to honorary membership in 1910; he served as vice-president of the Society from 1895 to 1897, and as president in 1899. His death on March 17, 1912, at the age of 71, ended a career full of adventure and achievement which added luster to the entire engineering profession. In his will, which was probated in 1914, he left a bequest to the Society, and stipulated that "the interest of such sum shall be paid annually to such competing members of the A.S.M.E. as shall present the best original paper or thesis on any mechanical-engineering subject presented to the Society for discussion and publication; the amount to be placed in the form of a gold medal, the design of which shall be made and decided upon by the Council of the Society or other competent body designated by it (Board of Honors and Awards); the medal may be presented annually and shall be known as the Melville Medal for original work." According to the rules formulated and adopted by the Society, the Committee on Medals, a special committee of the Board of Honors and Awards, annually reviews all papers presented before the A.S.M.E. the previous year, selects the "best" one, and recommends the author or authors to Council, through the Board, for the Melville Medal. The medal is usually presented during the Annual Meeting of the Society.

Inasmuch as no money was provided for the design or for the making of the die for a medal, Admiral Melville's bequest was held in abeyance until 1926, when the income on the fund and an additional amount provided by the Society itself made it possible to provide for the die and subsequent awards of the medal. On the obverse side of the medal, which was designed by James Earl Fraser, is a likeness of Admiral Melville in uniform; the reverse side, similar to that of the A.S.M.E. Medal, has the seal of the Society with the motto, "Give Me Where to Stand and I Will Move the Earth." The rim of each medal carries in raised letters the name of the recipient, the citation, and the date of award.

MELVILLE'S ADVENTURES IN MECHANICAL ENGINEERING

The Melville Medal, more than any other medal of the Society, is symbolic of the many adventures which await the mechanical engineer in the practice of his profession, a phase of engineering so well illustrated by the eventful life of Admiral Melville. Born in New York in 1841, he attended the Polytechnic School of Brooklyn and, later entered the engineering works of James Binn in Brooklyn where he acquired the foundation for that practical skill which served him so well in many a later event. With the outbreak of the Civil War, he was at once appointed an officer of the Engineering Corps of the U. S. Navy and throughout the war saw almost continuous service.

One of his many adventures during that period was in connection with the capture of the Confederate cruiser *Florida* in the neutral port of Bahia, Brazil. The Union screw sloop *Wachusett*, with Melville aboard, was already lying there at anchor, operating under orders to intercept Confederate cruisers, when the *Florida* arrived. Since the captain of the latter vessel refused an invitation for a fight beyond the three-mile limit, Captain Collins of the Union ship decided to destroy or capture the enemy ship in the harbor, international law or no international law.

Melville suggested ramming and this method was eventually followed. To certain objections, the 23-year old engineer replied, "I do not think the boilers will break loose; but if they do, there need be but one man sacrificed, for after the engines are started, I can work them alone after I order all hands on

The sixth of a series of articles prepared under the direction of the Board of Honors and Awards of The American Society of Mechanical Engineers, better to acquaint the members of the Society concerning the honors and awards which are given in recognition of meritorious achievements of engineers.

L. P. ALFORD

J. W. ROE

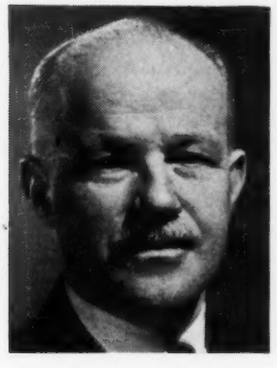
H. DIEDERICHS

W. D. POMEROY

A. E. GRUNERT

A. J. STEPANOFF

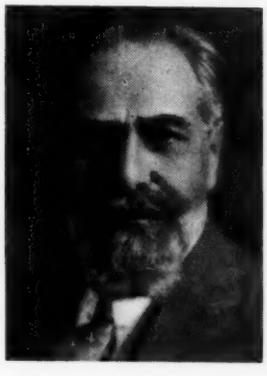
W. E. CALDWELL



O. R. WIKANDER

H. A. S. HOWARTH

A. J. BÜCHI



A. I. LIPETZ

Recipients of the Melville Award

deck." The *Florida* was rammed, as planned, promptly boarded by the crew of the *Wachusett*, and was captured and towed out of the harbor. Melville did not stay below alone since a seaman, Bradley, refused to leave him.

SERVICE AFTER CIVIL WAR

When the war ended, Melville was ordered to the *Tacony*, and, with her, served in the Mexican Gulf during the French occupation and evacuation of Mexico; later he joined the gunboat *Penobscot;* then cruised to Brazil in the flagship *Lancaster;* then to the Arctic in the steamer *Tigress* to rescue the crew of the *Polaris;* then to China and Japan in the flagship *Tennessee;* again to the Arctic in the steamer *Jeannette;* and yet again in the *Thetis* for the relief of the Greeley expedition. Melville's experiences on the ill-fated expedition of the *Jeannette* and the struggles of the remnant of the crew to fight their way back to civilization were related by him in a book called "In the Lena Delta," published in 1885. In 1938 Commander Edward Ellsberg wrote a "best seller" entitled "Hell on Ice: The Saga of the *Jeannette*," that was based on Melville's epic.

APPOINTED ENGINEER IN CHIEF OF NAVY

In 1887, Secretary of the Navy William C. Whitney, impressed by the rate of expansion of the Navy and the magnitude of the engineering problems connected therewith, decided that the existing vacancy as chief of the Bureau of Engineering must be filled by an engineer of great executive ability, vision, judgment, and force. Accordingly, he went well down the list of

junior chief engineers and selected George W. Melville, influenced chiefly, it is said, by Melville's record during the cruise of the *Jeannette*.

When he became chief of the Bureau and engineer in chief of the Navy, changes and improvements at once got under way. He put vertical, inverted main engines of short stroke and high speed in the *Maine;* he pioneered water-tube boilers, and boiler testing for fuel consumption. The Fuel Oil Board was created through his efforts, as well as the standardized screw method of ship trials, the Engineering Experiment Station at Annapolis, and postgraduate education in engineering in the Navy. As early as 1903 he was advocating the installation of turbines in one vessel of the Navy for experimental purposes.

During Melville's tour of duty as chief of the Bureau of Engineering and engineer in chief, from 1887 to 1903, a new Navy was built aggregating a million and a quarter horsepower. In 1899 came the culmination of the long fight which the engineers in the Navy had made to secure actual rank as naval officers instead of relative rank with professional titles. This was opposed for years by line officers, but the splendid work of the Engineer Corps under Melville and his personality made possible the recognition.

RETIRED IN 1903

In 1903 Admiral Melville retired from the service in accordance with the 62-year limit, though still active and vigorous both mentally and physically, and several years later he opened a consulting office in Philadelphia in partnership with J. H. Macalpine, the joint inventor with him of the steam-turbine reduction gear for ships and other purposes. Throughout his life Melville's inventive genius was constantly in evidence and there is a long list of inventions to his credit, most of which were never patented.

MEDALISTS

LEON P. ALFORD, fellow A.S.M.E., past vice-president of the Society, and chairman of the industrial-engineering department, New York University, was the first recipient of the Melville Medal in 1927 for his paper on "Laws of Manufacturing Management," which was published in MECHANICAL ENGINEERING for April, 1927.

JOSEPH W. ROE, member A.S.M.E., retired chairman of the industrial-engineering department, New York University, was awarded the 1929 Melville Medal at the Fiftieth Anniversary Meeting of the Society in Washington, D. C., April 8, 1930, for his paper, "Principles of Jig and Fixture Practice," which appeared in the December, 1928, issue of MECHANICAL ENGINEERING.

HERMAN DIEDERICHS and WILLIAM D. POMEROY, members A.S.M.E. until their deaths on Aug. 31, 1937, and Jan. 6, 1932, respectively, received, in 1930, Melville Medals for their joint paper, "The Occurrence and Elimination of Surge or Oscillating Pressure in Discharge Lines From Reciprocating Pumps," which was printed in the Transactions of the A.S.M.E., vol. 51, 1929.

ARTHUR E. GRUNERT, member A.S.M.E., superintendent, generating stations, Commonwealth Edison Company of Chicago, was awarded the 1931 Melville Medal for his study on the "Comparative Performance of a Pulverized-Coal-Fired Boiler Using Bin System and Unit of Firing," which was published in the Transactions of the A.S.M.E., vol. 53, 1931.

ALEXEY J. STEPANOFF, member A.S.M.E., design engineer, Byron-Jackson Co. of Los Angeles, was given the 1932 Melville Medal for his report on the "Leakage Loss and Axial Thrust in Centrifugal Pumps," which appeared in the Transactions of the A.S.M.E., vol. 54, 1932.

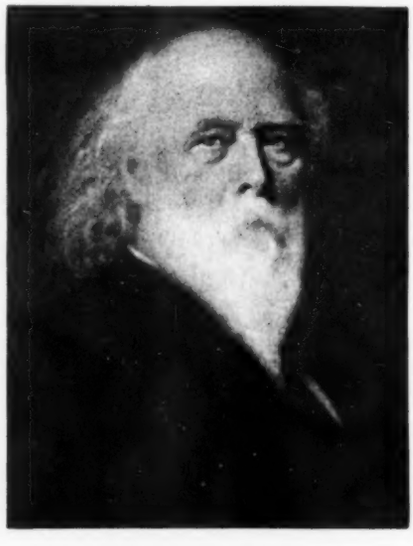
WILLIAM E. CALDWELL, member A.S.M.E., efficiency engineer, Consolidated Edison Company of New York, received the 1933 Melville Medal for his paper on the "Characteristics of Large Hell Gate Direct-Fired Boiler Units," which was printed in the Transactions of the A.S.M.E., vol. 56, 1934.

OSCAR R. WIKANDER, member A.S.M.E., mechanical engineer, Edgewater Steel Co. of Pittsburgh, was awarded the 1935 Melville Medal for his study on "Draft-Gear Action in Long Trains," which was published in the Transactions of the A.S.M.E., vol. 57, 1935.

H. A. STEVENS HOWARTH, member A.S.M.E., consulting engineer on thrust and journal bearings, Philadelphia, Pa., was the recipient of the 1936 Melville Medal for his paper on "The Loading and Friction of Thrust and Journal Bearings With Perfect Lubrication," which appeared in the Transactions of the A.S.M.E., vol. 57, 1935.

ALFRED J. BÜCHI, consulting engineer, Winterthur, Switzerland, received the 1937 Melville Medal for his paper, "Supercharging of Internal-Combustion Engines With Blowers Driven by Exhaust-Gas Turbines," which was printed in the Transactions of the A.S.M.E., vol. 59, 1937.

ALPHONSE I. LIPETZ, fellow A.S.M.E., chief consulting engineer, American Locomotive Co. of Schenectady, N. Y., was awarded the 1938 Melville Medal for his report on "The Air Resistance of Railroad Equipment," which was published in the Transactions of the A.S.M.E., vol. 59, 1937.



GEORGE WALLACE MELVILLE

What Is
ENGINEERING EXPERIENCE?

By CHARLES F. SCOTT

PRESIDENT, NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS

I DON'T understand why your board refuses to grant me a license as a professional engineer," said a young applicant to the secretary of a state registration board. "Your requirements are a diploma and four years of experience. I have a diploma and five years' experience, but you turn me down. Why is it?"

The reply of the secretary opened the eyes of the applicant.

"You have been doing routine work which has not added to your professional development," he said, "your experience is not 'satisfactory to the board.' "

Arbitrary as this reply may appear, the secretary was fully justified in making it, because the phrase "satisfactory to the board" is part of the wording of the law. If, therefore, so definite—or indefinite—a phrase is to be found in the law, is it not fitting that the registration boards should undertake an interpretation?

What kind of experience is "satisfactory to the board?"

The National Council of State Boards of Engineering Examiners has been studying this question, and received at its meeting in October, 1938, a report from its Committee on Qualifying Experience, of which the writer was chairman. The report, "Presenting a Situation: Not Attempting a Definition," was a composite of contributions by members of registration boards; it has been submitted for criticism to members of the boards in some forty states.

When the young man who looks forward to an engineering career seeks professional recognition, his experience record will be scrutinized by his engineering-society admissions committee and his registration board. In preparation for this scrutiny he will find much that may be helpful in the significant portions of the report which are here presented.

THE EXPERIENCE PERIOD

The experience period following graduation is a vital factor in the career of the individual engineer and in registration procedures. To the recent graduate this experience period is the opportunity for practice in using the knowledge and training of the past in laying the foundation for a future career.

To the engineering registration board the reaction of the applicant to the test of experience indicates whether the man has the qualities the professional engineer should have. It indicates his intellectual habits and attitudes, his methods of thinking and doing, his facility in combining theory and practice, his ability to handle new problems, to visualize, and to plan, his capability to develop as shown by the use he has made of opportunities for self-development. From the record of what he has done and how he has done it the board has the best basis for projecting his performance curve into the future, as indication of his competency to practice professional engineering.

THE MODEL LAW

State engineering registration laws are usually based upon the Model Law prepared by and recommended by a number of the national engineering societies.

According to the Model Law, "the practice of professional engineering . . . includes any professional service . . . wherein the public welfare or the safeguarding of life, health, or property is concerned or involved, when such professional services require the application of engineering principles and data."

It defines a "professional engineer" as ". . . a person who is qualified by reason of his knowledge of mathematics, the physical sciences, and the principles of engineering, acquired by professional education and practical experience, to engage in the practice of professional engineering." Hence the qualification involves the combination of knowledge and experience.

Normally, according to the Model Law, the requirements for registration are an acceptable diploma and a "specific record of an additional four years or more of experience in engineering work of a character satisfactory to the board, and indicating that the applicant is competent to practice professional engineering." (If there be no diploma a longer experience is required.)

"Four years or more" implies that the length of the period is to be adequate for acquiring the experience. The minimum of four years should be deemed sufficient only in exceptional cases where the experience has been unusually broad in scope, progressively better in character, and notably high in both average and final level.

"Character of experience" implies that some kinds of "experience" are not satisfactory; for example, routine performance which does not invoke the application of technical knowledge and which does not contribute to development of qualities which indicate competency to practice professional engineering. Character means *quality*, not mere *quantity* of experience measured in time (though a minimum is fixed) or jobs, and the quality must indicate competency.

SATISFACTORY EXPERIENCE

Broadly, character of experience that is satisfactory is that which indicates competency to practice professional engineering, and the "ability to do." Specifically, the following items are pertinent:

The school of experience should be a laboratory for the application of principles to the solving of problems. Knowledge and experience should become integrated so that they interact and produce something far beyond the arithmetical sum of textbook information and the doing of routine tasks.

On the same job one may exercise judgment in directing the work, while another may simply follow plans and specifications to the letter. Again, in design one may use judgment in choice of standards while another may make slavish use of them.

Qualifying experience is not derived from work which does not require or involve the application of engineering principles and theories although the work itself may require skill and may be necessary in professional activity, e.g., ordinary surveying, drafting, mechanical calculations, or routine-cost accounting. Acceptable experience must involve the intelligent practical application of the laws of physical science.

Experience should be sufficient in amount so that repetition produces (1) thorough understanding of the principles involved and (2) the development of judgment as to the method of analysis and solution.

Two phases of experience are (1) the actual activities performed and (2) the attitude of the individual and his progressive development in performing them. What he does is of less consequence than how he does it.

There is bound to be a dividing line between those who are indifferent to development and those who are bound to achieve against all obstacles, if professional engineering is to develop on the basis of higher standards.

A progressive advancement in the application of engineering data and principles should indicate that the applicant is capable of taking charge of some branch of engineering work. He should recognize his limitations as well as his ability, and should decline to accept a commitment that he knows he is not qualified to fulfill.

A board should secure details of an applicant's duties and responsibilities by asking such questions as these: What did he do? What engineering data or principles did he apply? What engineering judgment and discretion did he exercise? What was the scope and importance of the project? What is the ability to devise and to plan? What is the evidence of progressive responsibility? What initiative and originality and courage, and what personal force for overcoming difficulties have been shown? What aid to progress has been secured through reading and study, through membership in an engineering society, through correspondence-school or night-school courses?

Obviously, a board cannot rely on titles—they may be very deceptive. Jobs and positions and things done are significant only as to qualities essential to the professional engineer which result.

Practical experience is thus defined in handbook No. 36 of the New York State Board:

> Practical experience in professional engineering work to be considered to be of a grade and character satisfactory to the Board of Examiners shall be such as to require the intensive application of engineering principles in the practical solution of engineering problems. This work shall predicate a knowledge of engineering mathematics, physical and applied sciences, properties of materials, and the fundamental principles of engineering design. It shall be broad in scope and of such nature as to develop and mature the applicant's engineering knowledge and judgment.

In general, registrants who possess administrative ability are eligible for the higher ranks in their profession, they have desirable qualities for making them "competent to practice professional engineering."

Administrative ability is, therefore, a desirable though not an essential quality; it may be given consideration in estimating experience as qualifying for "professional engineering" practice.

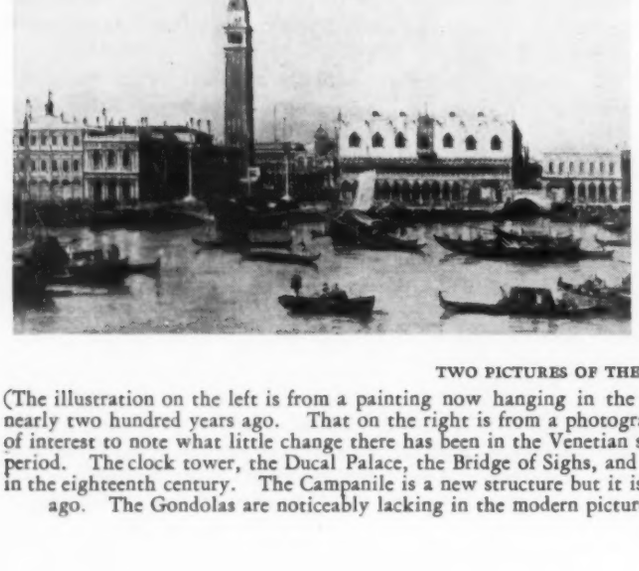
Professional engineering (as defined in the Model Law) includes ". . . evaluation, planning . . . in connection with any public or private utilities . . . works or projects, wherein the public welfare, or the safeguarding of life, health, or property is concerned." It seems reasonable, then, to expect more than mere physical competency.

Economic justification and social utility are within the larger engineering perspective. Ability to take this larger view and to coordinate many engineering elements in a single project and to adjust it to the environment outside the technical elements, by looking beyond engineering efficiency to social utility and public welfare, is a quality of our outstanding engineers—a quality to be developed through the years. But, if added to normal knowledge and experience a young man gives promise of a larger outlook on engineering and life, the board enjoys a double assurance that it is making a wise selection.

REGISTRATION—A NEW DEVELOPMENT IN ENGINEERING

Engineering registration in theory and practice is a pioneering effort. Ninety per cent of the forty states having registration have not had it more than twenty years and thirty per cent of them have had it less than four years. In some states the procedures in licensing are well developed; in others they are just beginning. The National Council seeks to interchange information and unify objectives.

Just as engineering schools and societies and engineering theory and practice progress, so must the goals and the procedures in engineering registration. The evaluation of experience cannot be effected through dogmatic definition; discretion must be exercised in each specific case. The applicant should realize that the true function of technical knowledge and qualifying experience is to produce competency to practice professional engineering. This may seem indefinite and intangible. It is. It cannot be measured by objective yardsticks; there is a human quality involved in interpreting what is "satisfactory to the board."



TWO PICTURES OF THE WATERFRONT OF VENICE

(The illustration on the left is from a painting now hanging in the Alte Pinakothek art museum in Munich, and executed by Canaletto nearly two hundred years ago. That on the right is from a photograph taken last summer by Sydney Withington, member A.S.M.E. It is of interest to note what little change there has been in the Venetian sky line, compared, for instance, with the New York sky line in the same period. The clock tower, the Ducal Palace, the Bridge of Sighs, and even the three flag poles in front of St. Mark's are all just as they were in the eighteenth century. The Campanile is a new structure but it is built on exactly the same lines as the one which fell about thirty years ago. The Gondolas are noticeably lacking in the modern picture, because they now appear on this stretch of water only at night.)

GOVERNMENT SPENDING *and* ECONOMIC RECOVERY

By DAVID W. LUSHER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PERHAPS ONE of the most important characteristics discernible in the history of governmental activity is the manner in which it has continually expanded and enlarged its sphere of significance in the social order. To many, this expansion is recognized as a phenomenon of quite recent origin, and as opposed to the "laissez-faire" attitude of government during the nineteenth century. Further, the expansion is looked upon with frowning displeasure, and criticized as being an artificially enforced development, inimical to the welfare of society. A closer examination of historical data discloses, however, that this tendency for governmental functions and services to become expanded and extended, was as true of the nineteenth century as it is of our own day. It is quite true that the rate of change as within each of the two periods was different, not because the governments of one period displayed more deliberate efforts to usurp for themselves an increasing range of functions, but rather because the conditions and events of the times led to a *natural* and most frequently necessary allocation of new functions to the governmental sphere, as well as the extension of old services.

During the period 1933 to 1937, the American economic system recovered appreciably from the depression into which it had sunk after 1929. Throughout that time the government played an eminently important rôle in the attempts made to bring about recovery. Several passages in the volume under review[1] make it clear that this depression is not the first to witness recovery measures undertaken by a government. (See particularly the section entitled "The Development of Ideas on Government Spending," reprinted from J. H. Clark's "Economics of Planning Public Works," cf. p. 19 et seq.). It is only with this depression, however, that it has become a definitely stated policy and function of government to frame a complete program aimed at restoring the economic system to its proper level of activity. In the light of the reviewer's thesis that governmental activity is characterized by a form of evolutionary expansion, and in the light of certain views which have been expressed recently with respect to the nature of our present economy, it seems that the formulation and exercise of recovery measures, indeed even an increased participation in our normal economic life, might well become a permanent function of the government. To ascertain with any degree of certainty whether or not this condition is necessary, one must undertake a detailed examination of the nature of the depressions which we have had since 1929, as well as the character of our whole economy with reference to its past, present, and possible future condition. In addition, the investigation would have to include an analysis of the part the government has played and might come to play in the maintenance or betterment of the economy.

A large body of material already exists which can be used for the type of examination suggested. To the reviewer's knowledge, however, no single work has been written, or at least published, which ranges over the whole field with reasonable completeness; rather, the bulk of the material is in the form of many comparatively fragmentary studies dealing with particular or specific phases of the whole problem. Ordinarily, therefore, the examination suggested would necessitate a prior research into the literature available, and a careful selection of material—a task much too imposing for the nonspecialist. Fortunately, the recently published book "Government Spending and Economic Recovery," performs the valuable service of doing all this heavy preliminary work. The editors, a professional economist, and a director of debate, have brought together in this volume a wealth of material pertinent to an understanding of the federal government's position in our national economy.

The various reprinted studies have been arranged by the editors in eleven chapters, with editorial notes preceding each chapter; and the various topics contained within each chapter, which though brief, succeed reasonably well in unifying and giving continuity to the subject. The first introductory chapter presents a picture of the background of depression, and traces the early efforts of the Hoover and Roosevelt administrations to moderate the severity of the depression and to bring about recovery. The second chapter entitled "Varieties of Economic Dislocations" deals with the nature and character of business cycles. The content of the third chapter is suggested in the title, "The Theory of Business Recovery Through Government Spending." The fourth and fifth chapters, "Government Spending-Lending in Action: The United States," describe the various agencies and their work, which have been set up by the government in the exercise of its policy.

Chapter six recounts the experience of Sweden, Germany, and other foreign countries in their "spending-lending" efforts to restore prosperity. Chapter seven, "Government Spending-Lending as a Means of Economic Recovery," attempts to evaluate both the theoretical views which have been expressed with respect to government spending-lending, and the concrete results of such policies in this country and abroad. Chapter eight deals more particularly with the "Financial Aspects of Government Spending." Chapter nine indicates "Some Social and Political Implications of Government Spending." And the concluding chapters ten and eleven suggest "Some Alternatives to a Spending-Lending Program."

In selecting the topics which would seem to warrant more attention than others we must obviously do so with an eye to the fundamental questions relevant to the studies of government in the economic order. These can be stated briefly and without need for much expansion: First, can the private economy of itself, without aid from the government, recover from the present, and possible future depressions; (more basically, the question is whether the private economy can prevent or compensate depressions); second, can the government by itself, or rather by aiding the private economy, bring about re-

[1] "Government Spending and Economic Recovery," by C. F. Phillips and J. V. Garland. (Contemporary Social Problems. Discussion Series No. 1), The H. W. Wilson Co., 1938.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

covery; and third, what later repercussions, salutary or injurious, can be expected?

Answers to the more basic form of the first question are formulated in reprints of articles by S. H. Slichter and A. D. Gayer. Professor Slichter presents evidence to support the view that the private economy, based as it is on the profit motive, must inevitably be given to fluctuation, since profit-making prospects themselves must fluctuate because of the very nature of the private economy. If then we are to have a stabilized economy, Professor Slichter is convinced that there is a "need of developing large expenditures which are not dependent on profit prospects and of dovetailing them with the expenditures which do depend on profit prospects." (Cf. pp. 73–74.) Mr. Gayer sees the need "for government deficit spending as a recovery expedient because of the seemingly insuperable difficulty of securing an adequate general reduction of costs and prices in depression, in consequence of the extent to which our economy is permeated today by inflexible elements." "If so-called natural forces are relied upon to bring about recovery, the vicious spiral may accordingly continue indefinitely, with cumulative deflationary intensity, and the argument for government intervention to break the circle becomes strong." (Cf. pp. 75–76.)

With more direct reference to the depression as it was around 1933, Mr. Gayer analyzes some of the basic data relevant to an understanding of the nature of the depression, and finds it necessary to conclude that "the prospects of a so-called natural recovery (were) slender (and that) a strong case existed for the government to try to bring one about through increased deficit spending."

Thus far, therefore, the evidence seems to indicate that, left to itself, the private economy could not show a sufficient amount of recuperative strength to restore itself to a prosperity level, once it enters a depression. At this point, the reader may justifiably be tempted to ask whether it is not true that in past business cycles the economy has, mainly on its own efforts, recovered from a depressed state—and if it is true, why can't we expect the private economy to recover from this depression? It would seem, granted that our economic system is very much the same as it always has been, that it should be able to do what it has done before, namely, recover from depression. But it is just on that score that many economists base their contention that the private economy is no longer able to recuperate from depressions—the economy is not the same as it always has been. In the past the system had been able to return to prosperity levels because of the investment opportunities which existed and were seized. Today, little room exists for new private investments. In other words a progressive economy has enabled us to come out of past depressions, but a stagnant, stationary economy cannot perform the same service today. For the reviewer's part, the evidence for this argument though strong is not at all conclusive. Perhaps all that can be said with any reasonable degree of certainty is that with respect to the immediate future, investment openings do seem limited; what opportunities will exist at a much later future is difficult to surmise.

The foregoing remarks suggest the possibility that governmental intervention in the economic system may have more significance from the long-run point of view than from the business cycle, or shorter viewpoint. Although the present volume suggests some of the problems connected with the permanent long-run intervention of governmental activity in the private economy, it does not enter into them in an explicit form, and it is well, therefore, to limit ourselves to the business-cycle problem, which leads directly to our second fundamental question as to whether a government spending program can aid recovery. On the whole the theoretical evidence is that it can. The editors present part of J. M. Clark's "Economics of Planning Public Works," which is one of the best studies on the subject of government spending. The reprint contains the analysis of the primary and secondary effects of government expenditures based on the Keynesian multiplier. It is quite clear from the study that government spending by having a multiple influence in raising the national income is conducive to recovery. In the last analysis, however, it is evident that no amount of government spending can be effective if at the same time it discourages private spending. Whether it has done so in recent years is difficult to ascertain one way or the other. But it is possible to show that on rational grounds there is no call for private spending to be frightened away by government spending. Unfortunately however, to do so is not to resolve the difficulty; even if a curtailment of private spending is irrational it can nevertheless be effective in neutralizing governmental expenditures.

One definite experience does exist which indicates that even if government spending does discourage private outlays, it does not do so to the extent that the expenditures of the former are completely neutralized by the lack of expenditures of the latter kind. If the 1933–1937 recovery can be shown to be due mainly to governmental efforts, the case is clear. And to the reviewer's mind, both from the evidence spread through this volume and available in outside sources, the recovery was induced primarily by the government's "spending-lending" policies.

Turning to our last question as to the possible future repercussions of the governmental expenditures, the volume offers the views of Paul Studenski and J. H. Rogers. Both point out the dangers of inflation that exist because of the government's financial policy, Mr. Rogers doing so thoroughly in some detail. But both may be said to feel that inflation is far from inevitable, but rather that it can be avoided or controlled. To prevent inflation, Mr. Studenski indicates that the government must, with revival, "modify its financial policy. It cannot continue, during recovery, a policy it pursued during depression. It must increase taxes, gradually reduce expenditures, bring income and expenditures into closer accord, reduce and soon stop completely further borrowing, and, when recovery finally turns into prosperity, begin to liquidate the debt."

There can be little doubt that the views on inflation reprinted in the volume are quite sound, but it is not the sole repercussion that may conceivably arise out of the government's financial policy. Little is indicated, for example, of the possible economic influences of debt retirement and of the effect of the governmental financial policy on capital formation. On this subject and others the editors can be criticized for failing to include analyses on several problems which to the reviewer's mind warrant priority of space over some of the material utilized.[2] Further, the editors may well have economized on space by pruning, somewhat more closely, several articles which seem repetitive. Perhaps, however, these faults can be overlooked in a volume performing a notable service.

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[2] Perhaps the most important of such problems which might have been included to advantage is that of the possible lack of new investment outlets in the private economy. The significance of that problem with respect to the part the government may be forced to assume in the economy has already been touched upon. Its further import may be judged from the question which has been posed so frequently of late, namely, "Is capital on strike?" The accusation has been made that businessmen have refrained from making investments in protest against governmental policies. The defense of business has been that investments are much too risky in the face of the government's attitude. The implication is, of course, that an appreciable volume of investment would be forthcoming if business were assured of a more friendly attitude on the part of the government. In a sense, if the latter argument is true, capital is on strike in that it is not flowing into available investment opportunities. But, for some, there seems good reason to believe that investment outlets do not exist, at least not in considerable volume—which changes the whole complexion of the controversy, and suggests that some alterations must be made in our economy.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

APPEASEMENT, the dominant note in European politics last fall, has become an oft-repeated word in recent comments on the situation here at home. Mechanical engineers have more than a general interest in the recently announced shift of emphasis from reform to recovery and in the indications of the existence of an atmosphere of appeasement in the strained relations that have been persistent for so many years between the government and business.

Hoped-for stimulation of the capital-goods industries, with which a majority of mechanical engineers are concerned, was advanced in the last month not so much by any measurable increase in the capital-goods industries themselves or private investments in them and in new projects as it has been by the overtures of Administration spokesmen looking toward a resumption of long-term investment in productive enterprises and in promises that taxes are not to be increased and that "this Administration is now determined to promote that recovery with all the vigor and power at its command," as the new Secretary of Commerce phrased it in his Des Moines speech.

Indexes of the Nation's economic life, while they may have confounded some of the most thoroughgoing pessimists, have reflected a tendency to mark time, rather than positive advancement. Skepticism that any permanent change of heart has taken place still persists. With a well-defined tendency to cease being a rubber stamp, the Congress and particularly some of its leaders, as for example Senator Harrison, have shown resistance to the philosophy of spending. A considerable amount was lopped off the President's request for an appropriation for relief, and it is reported that the mood is to reduce somewhat many of the budget requests. Secretary Hopkins has announced the appointment of General Wood of Sears Roebuck as his adviser, and it is said that in order to allay business fears the investigations of Senator O'Mahoney's antimonopoly committee may be soft-pedaled. Unemployment, according to figures released by the National Industrial Conference Board increased from 9,913,000 in December to 10,645,000 in January, proving that the nation's most serious problem is still unsolved, and providing, possibly, a spur to the Administration's policy of appeasement.

Settlement of the purchase price to be paid by the TVA for the utilities which Mr. Wilkie represents was an encouraging sign in the desperate controversy over government competition in the electric power industry, but the abortive attempt to hold up appropriations for the Gilbertsville Dam project and the uncertainty about the proposed Bonneville transmission line were a very considerable "fly in the ointment."

On the labor front, in which engineers, from their peculiar position of standing midway between owner and employee in industrial enterprises, have a decided interest, two important events have been placed on the record. The Supreme Court handed down decisions that should clarify the positions of all concerned in certain phases of labor disputes and the N.L.R.B. However, it has been pointed out by many able commentators that the decisions, in reality, demonstrate the need for revision of the Wagner act. Changes in the personnel of the Court may conceivably so modify its majority opinion as to make possible a reversal of the recent decisions.

What will be the outcome of the scheduled conference, at the President's request, between representatives of the A.F.ofL. and the C.I.O. can scarcely be predicted and will be awaited with great interest.

Debate in the Congress on appropriations for military aircraft has been long and vigorously argued, but no one doubts that great activity in aircraft construction will be an important engineering factor for many years to come. The array of talent that must be brought to bear in this growing industry will draw upon practically every kind of scientific and technological skill, from research to production and operation.

Mathematical Center

Announcement has been made of the establishment of a "center" of mathematical analysis to direct the use of new types of calculating machines at the Massachusetts Institute of Technology. The new project has been made possible by a grant of $45,000 by the Carnegie Corporation of New York.

The purpose of the project is said to be to encourage and assist technological advance in all fields by making available to scientific institutions and industry the means of carrying out intricate mathematical processes economically. Active development of new machines and analytical methods of using them will be carried out. Provision is made for a staff to operate the machines developed at the Institute. Prof. S. H. Caldwell is to direct the project, which is expected to be in operation in the fall.

Manifesto

Newspapers devoted considerable space to a " 'Manifesto' by a Physicist," a statement of his position in respect to offering assistance to "citizens of any totalitarian state," published by P. W. Bridgman, of Harvard University, in the February 24 issue of *Science*. A paper by Professor Bridgman appeared in the February issue of MECHANICAL ENGINEERING.

Professor Bridgman's "statement," which, he explains, he has had printed and hands "to any prospective visitor who may present himself" at his laboratory, follows:

> I have decided from now on not to show my apparatus or discuss my experiments with the citizens of any totalitarian state. A citizen of such a state is no longer a free individual, but he may be compelled to engage in any activity whatever to advance the purposes of that state. The purposes of the totalitarian states have shown themselves to be in irreconcilable conflict with the purposes of free states. In particular, the totalitarian states do not recognize that the free cultivation of scientific knowledge for its own sake is a worthy end of human endeavor, but have commandeered the scientific activities of their citizens to serve

their own purposes. These states have thus annulled the ground which formerly justified and made a pleasure of the free sharing of scientific knowledge between individuals of different countries. A self-respecting recognition of this altered situation demands that this practice be stopped. Cessation of scientific intercourse with the totalitarian states serves the double purpose of making more difficult the misuse of scientific information by these states, and of giving the individual opportunity to express his abhorrence of their practice.

This statement is made entirely in my individual capacity and has no connection whatever with any policy of the university.

Production Research

Last December, in an address at the inauguration of the Nottingham Section of the Institution of Production Engineers (Great Britain), Lord Sempill, deputy president of the Institution, announced that a research laboratory would be opened at Loughborough Technical College under the auspices of the Institution and under the direction of Georg Schlesinger, member A.S.M.E., well known in Russia and Germany for his work in laying out modern factories and to the machine-tool industry for his researches in connection with machine-tool tests and alignments.

A note on the new laboratory in the Jan. 5, 1939, issue of *Machinery*, states that among the subjects suggested for research are materials and tools for cold-forming, standardization and measurement of surface finish, effect of vibration on production efficiency, machine guards and the possibility of their standardization, modern cutting alloys, and cutting fluids. Standardization of machine-tool tests and alignments, design of machine tools from a user's point of view, and comparison of ground with scraped slides, and of hardened-steel ways with ways which have been machined from chilled castings, are mentioned as possible subjects for study.

It is said that the project was made possible because of the gift of 25,000 pounds by Lord Nuffield, president of the Institution.

Twin Ships

Robert Fulton bobbed up again last month when a 90-page illustrated pamphlet entitled "Twin Ships," was received from The Mariners' Museum, Newport News, Va., with a note referring to page 16. On page 16 is a reproduction of Fulton's drawing of a "double" ferry steamer accompanying his patent specification of 1809. The original of this drawing hangs in the offices of The American Society of Mechanical Engineers, New York.

The pamphlet, which bears the subtitle, "Notes on the Chronological History of the Use of Multiple Hull Vessels," was prepared by Alexander Crosby Brown, corresponding secretary of the museum, and presents a fascinating story, amply illustrated with 33 reproductions of old prints and photographs. Catamarans, propelled by steam and sail, many of which were actually built and operated while others never got beyond the "paper" stage, have a long and interesting history. In the chronological table of the pamphlet Sir William Petty's "sluice boat" *Simon & Jude* (*Invention I*), of 1662, heads the list and the *Kaimiloa*, 45-foot ocean-going Hawaiian catamaran, of 1937, completes it. A supplementary table of Lower Mississippi steam catamaran ferryboats which are in commission and listed in the 1937 Register, the oldest of which was built in 1892 and the newest in 1929, removes all doubt that the idea of a twin-hulled ship has been abandoned.

That the catamaran was indigenous to certain parts of the world is attested by the surprise expressed by the Tahitians that Captain Samuel Wallace's *Dolphin*, which sailed into Mataivai Bay in 1767, did not turn over because it had only one hull. To the Tahitians the catamaran or pahi was the natural form of a ship, and they constructed them in large sizes, e.g., Captain James Cook, in May, 1774, took off the lines of one that measured 108 ft in over-all length.

So many novel, ingenious, and fantastic twin-hulled ships are mentioned and illustrated in the pamphlet that one could go on referring to them for several pages. Any engineer interested in ships (and is there any who is not?), will get a vast amount of information and pleasure out of this well-documented monograph.

Elihu Thomson

The life and work of the late Prof. Elihu Thomson, honorary member A.S.M.E., eminent scientist, and one of the founders of the General Electric Company, was recalled at a commemorative meeting in Philadelphia on Feb. 16, 1939. Nine papers dealing with different phases of Professor Thomson's work were read by Karl T. Compton, W. D. Coolidge, Vannevar Bush, Dugald C. Jackson, Albert G. Davis, Harlan T. Stetson, Roland S. Morris, Albert L. Rohrer, and John L. Haney. The papers, it is said, are to be coordinated with other material now in the files of The Franklin Institute to form the nucleus of Thomson's biography, a work which scientists and engineers will await with pleasant anticipation.

The meeting was sponsored by The Franklin Institute, the Philadelphia Central High School, the Massachusetts Institute of Technology, and the General Electric Company, and was held in the halls of The Franklin Institute and the American Philosophical Society.

In 1880 Professor Thomson gave up his teaching at the Boys Central High School, Philadelphia, where as an instructor he began his work of discovery and invention, and joined the newly formed American Electric Company in New Britain, Conn., forerunner of the Thomson-Houston Electric Company and later consolidated with Thomas A. Edison's company in Schenectady to form the present General Electric Company. He died in 1937 at the age of 84, after a lifetime of development and invention that brought him the world's highest scientific honors.

Awards in Industry

Watt, the instrument maker, assigned to the repair of a working model of Newcomen's atmospheric engine, conceived improvements in it that laid the foundation for extensive and brilliant developments in the steam engine. Frequently as this story is told it can bear retelling as an example of the contributions that an active and inventive mind can make in the discharge of a routine task. Honor and encouragement to men of this type constitute a sound investment for industry and are particularly appropriate in an era when so much is heard about the deadening influence of modern workshop conditions on the minds of workers. It is heartening, therefore, to read the announcement of the General Electric Company's recognition accorded to 18 of its employees for industrial progress in 1938. In the words of the announcement:

Four workmen in the factories and three factory foremen, whose inventive minds found ways to improve the products they worked on and to save thousands of dollars in manufacturing costs, were among those accorded the company's highest honor, the Charles A. Coffin award.

Along with the work of four engineers who produced a new type of wire important in the manufacture of motors, the com-

pany rated the achievements of an instrument maker who found means of increasing the already delicate findings of the equipment he used.

A millwright, whose 127 suggestions resulted in 78 improvements in manufacturing methods in the refrigerator department, was placed on the honor roll with an engineer who developed a revolutionary process of annealing malleable iron.

The accomplishments of the 18 men were outstanding among those of 60,000 workers. The awards, consisting of a framed certificate and a cash honorarium, are made by a foundation established in 1922 to perpetuate the memory of the company's founder, the late Charles A. Coffin.

Miners

Too late in the month for comment in the March issue was the 150th meeting of the American Institute of Mining and Metallurgical Engineers held in New York, Feb. 13 to 16, 1939, and attended by upward of 2000 persons. From the friendly bustle in the lobby of the Engineering Societies Building there was no doubt in an observer's mind that the meeting was a success. As has been remarked in this column before, the Miners seem to enjoy their gatherings in New York more whole-heartedly than any other group. One suspects that they have cultivated the fine art of combining business with pleasure to a marked degree, and they certainly take the sting out of the usual criticism of engineers that they are ill at ease when they step out of their technological rôles.

Starting out with a "subscription breakfast" and committee meetings on Monday morning, the program listed technical sessions, luncheons, dinners, smokers, dances, and even a dinner-smoker at Billy Rose's "Diamond Horseshoe," and ended, for a few at least, with a Bermuda cruise. Special features included an "All-Institute" meeting on Monday afternoon with addresses by Rear-Admiral Clark Woodward, U. S. Navy, "Industry's Relation to National Defense;" and by Tom M. Girdler, of the Republic Steel Corporation, "Some Economic Problems of the Mineral Industry." Institute affairs were discussed at the annual business meeting on Tuesday and at meetings of the section delegates. Daniel Hanson, of the University of Birmingham, England, delivered the Institute of Metals annual lecture, his subject being "The Creep of Metals." The Howe Lecture was presented by H. W. Gillett, Battelle Memorial Institute; he discussed "Some Things We Don't Know About the Creep of Metals." At the Petroleum Division's annual dinner Harry C. Weiss of the Humble Oil and Refining Company was the speaker; his subject, "Some Current Problems in Oil Conservation."

Medals and honors were presented at the annual dinner of the Institute held at the Waldorf-Astoria. The William Lawrence Saunders Gold Medal was presented to Louis Shattuck Cates "for signal accomplishment in the conception and application of superior mining technique and in the organization and administration of major mining and metallurgical enterprise." Kenneth Charles McCutcheon and John Chipman received the Robert W. Hunt award for 1939. The Institute of Metals Division annual award went to Frederick N. Rhines and Robert F. Mehl, and the Alfred Noble Prize of the Founder Societies and the Western Society of Engineers was presented to Ralph J. Schilthuis. Herbert Hoover, honorary member A.S.M.E., and Donald B. Gilles, president A.I.M.E. 1939, spoke at the dinner. Daniel Cowan Jackling, president A.I.M.E. for 1938, acted as toastmaster.

In his address at the "All-Institute" meeting on Monday afternoon Mr. Girdler said that no problem is of greater moment to the United States of today or of tomorrow than its wealth underground. Reviewing the country's production statistics for copper, zinc, aluminum, coal, lead, oil, iron ore, phosphates, and potash, Mr. Girdler called attention to such "missing links" as chromium, cobalt, manganese, nickel, tin, tungsten, and vanadium. "All these materials are essential to the modern steel industry," he said. "In peace or in war it is imperative that they be available in adequate supply. I am impressed by the logic of the proposal for government-acquired reserve of at least two years' needs."

Mr. Girdler also said that "war brings no genuine prosperity to the steel industry," that "it is not in the public interest that the mining industry be throttled by ruinous taxes," and that the industry "can serve the country far better through private initiative than under any form of bureaucratic control."

The "KdF" Volkswagen

THE AUTOMOBILE ENGINEER (GREAT BRITAIN)

AMONG the exhibits to be seen for the first time at the International Motor Show in Berlin, Feb. 17 to Mar. 5, 1939, was the new German "KdF" Volkswagen (people's car), of which so much has been written in the daily press during the last five years. The building of the car is part of the "strength through joy" or "Kraft durch Freude" movement. Hence the abbreviated title, KdF, by which the car is known.

The company engaged in producing the car was inaugurated by the German Labor Front with a capital of rm 50,000,000 (over $20,000,000), partly obtained by advance payments on 170,000 cars which have been ordered but will not be delivered

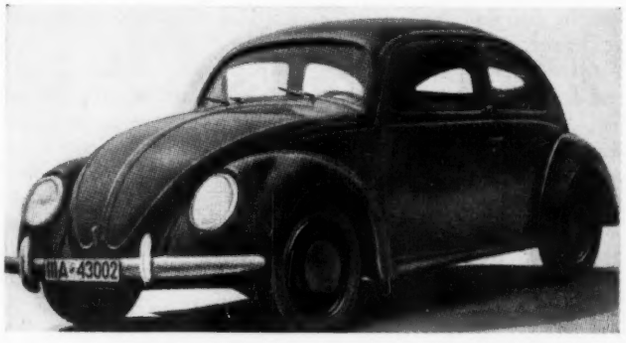


FIG. 1 THE REAR-ENGINED FOUR-SEATER VOLKSWAGEN

until the latter part of this year. A plant, with a frontage of two and a half miles, was started in May, 1938, at Fallersleben, near Hanover, and will be fully completed by October, 1939. The design of the car was entrusted to Dr. Ferdinand Porsche and Jacob Werlin, of the Daimler-Benz Company, and other well-known German automobile engineers have collaborated in the planning of the factory and production of the new car. According to reports from Germany, the car is of such advanced construction that no important modification will be necessary for another five or ten years.

The description of the car, which follows, is abstracted from an article by Rolf L. Binder, appearing in *The Automobile Engineer* (Great Britain) for February, 1939. The general appearance of the rear-engined vehicle (Fig. 1) indicates the use made of advanced design to gain body space on a relatively small chassis. The body is made of pressed steel and has a generally streamlined contour with rounded surfaces, yet at the same time a good ground clearance has been obtained. Clutch, brake, and accelerator pedals are in the usual locations. The seating is sprung, the front seats being adjustable and having

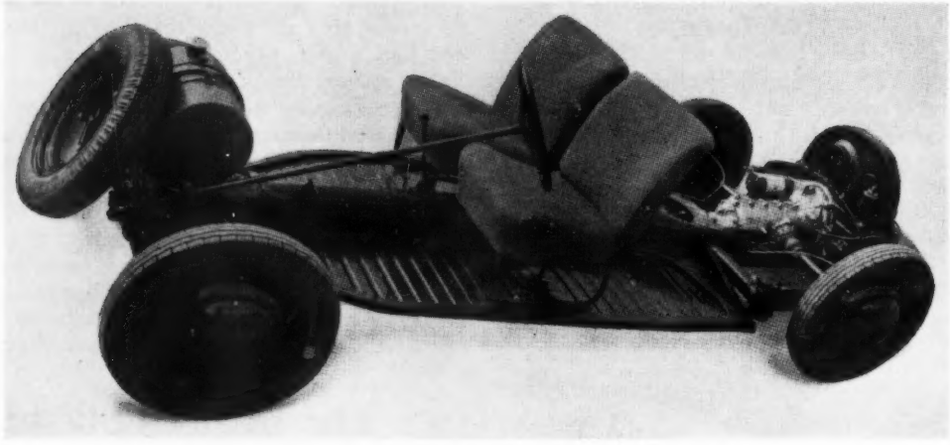


FIG. 2 VIEW OF CHASSIS OF VOLKSWAGEN

tubular chromium-plated steel frames. Mounted between the two front seats, the hand brake lies nearly horizontal.

The chassis consists of one single center rail of the so-called "back-bone" type. This tubular frame, as shown in Fig. 2, forks to the rear to carry the engine, gear, and differential. At the front part, the frame carries the spare wheel and the gasoline tank and has various flanges for the attachment of the steering system and front springs. The tubular rails, which reinforce the frame construction, serve also to heat the interior of the car, this being of particular importance for cars used during the cold winters experienced on the Continent. The seats are placed between the axles, thus providing an ideal weight distribution of 44 per cent at the front and 56 per cent at the rear.

All wheels are independently suspended by torsion springs, the driving axles being full-floating. The springs are assisted by telescopic shock absorbers. This results in a very low center of gravity, so that side sway and body roll are at a minimum when taking sharp curves at high speeds. Mechanical internal expanding four-wheel brakes are used, the brake cables being fully enclosed and dust-sealed. The hand brake operates mechanically on all four wheels. The size of tires is 4.50 × 16, and the wheel base is 94 in. Weighing 1400 lb, the car has a road clearance of approximately $8\frac{1}{2}$ in. with a load of 800 lb. The over-all length of the car is 165 in., and the width and height are both 61 in.

Of interest is the horizontally opposed four-cylinder air-cooled engine mounted at the rear of the chassis and shown in Fig. 3. It has a displacement of 60 cu in., with a designed output of 23.5 hp. The crankcase is made of light alloy, ribbed at the bottom for cooling the lubricating oil. The separate air-cooled cylinders are mounted two at each side, each pair having a common detachable head with overhead valves operated by push rods and rockers. The fuel-intake system comprises a pipe, on which a downdraft carburetor is mounted, running across the top of the engine and being attached to double ports in each cylinder head. The compression ratio is such that any fuels can be used. The valve gear is totally enclosed. When fully assembled the engine is covered by a sheet-metal cowl, surrounding the cylinders and the cylinder heads. On the end of the generator shaft there is mounted a light-alloy centrifugal blower delivering air through ducts in the cowling. This assembly is driven by a V-belt from a pulley on the crankshaft. An oil cooler mounted on the crankcase projects vertically upward. Since the tail panel of the body is hinged, the engine auxiliaries are readily accessible and the engine may be removed in ten minutes.

In front of the engine and in one unit with it, there is mounted a four-speed gearbox and the final drive gear, with its half couplings for the swinging half axles. Alongside the gearbox is the starter which engages with the flywheel. The gearbox casing is made of light alloy and split longitudinally. Although of small capacity, the engine is claimed to provide a good performance, with fuel consumption of the order of 40, or more, miles per gallon, by reason of the favorable power-to-weight ratio of 60.9 lb per hp. A maximum speed of over 60 mph has been obtained in extensive road tests, many of the test cars covering more than 100,000 miles without any breakdowns or serious engine trouble.

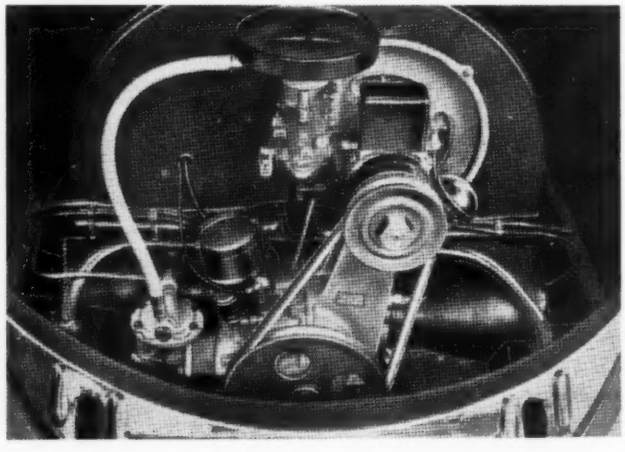


FIG. 3 FOUR-CYLINDER ENGINE OF THE VOLKSWAGEN

Jendrassik Combustion Turbine

ENGINEERING

PRODUCTION of mechanical work by means of an internal-combustion turbine has been attempted in various ways during recent years. Tests, such as those described by Holzwarth in "Die Gasturbine," carried out in prewar days with explosion gas turbines were highly promising, but the designers did not succeed in attaining satisfactory efficiencies in transforming the energy available at the turbine nozzles into mechanical work at the shaft. After these trials, no further results were published. Combustion turbines operating at constant pressure, with air supplied by a compressor, as distinct

from explosion turbines, have also been proposed and built. The highest permissible temperature in a turbine of this type is determined by the properties of the blading material, and preferably should not exceed 900 F, or, at most, 1100 F. With these temperatures, however, a satisfactory over-all efficiency can only be obtained if both the compressor and turbine possess very high efficiencies. It is probably for this reason that the combustion turbine has not been able to develop sooner.

In the Feb. 17, 1939, issue of *Engineering* is an article on a new type of combustion turbine, operating at constant pressure, developed by a Hungarian engineer, George Jendrassik, of Budapest, with financial assistance provided by the Royal Hungarian Ministry for Industrial Affairs. The unit develops about 100 hp at 16,400 rpm. The layout of the plant is shown in Fig. 4. The turbine blading is of heat-resisting steel, and the compressor blading of aluminum. Tests at the Royal Hungarian Institute for Technology showed that the unit had an over-all efficiency of 21.2 per cent, this being the relation of the useful work, as measured by a brake, to the net calorific value of the gas oil used as fuel. The actual test figures were as follows:

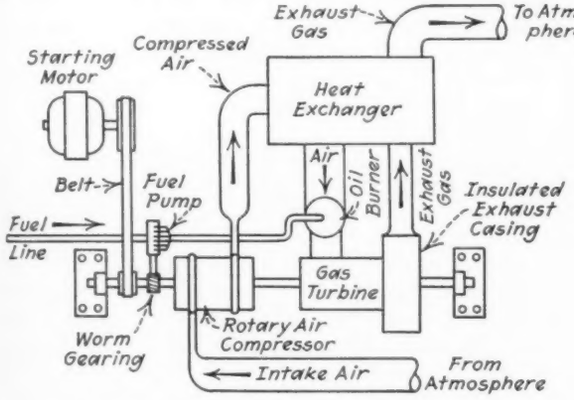


FIG. 4 LAYOUT OF JENDRASSIK COMBUSTION-TURBINE UNIT

Speed, 16,400 rpm; 98.5 bhp; fuel consumed per hour, 62.8 lb; air temperature at compressor suction, 37 F; temperature of gases at turbine inlet, 890 F; barometric pressure, 29.7 in. Hg; gage pressure at compressure delivery, 35.1 in. Hg; and calorific value of fuel, 4700 cal per lb.

The various component parts of the installation may be identified by reference to Fig. 4. The compressor and the turbine are mounted coaxially, the former being the unit to which are connected the two large vertical air-duct branches. Air is drawn in from the atmosphere to the rotary compressor, which has ten stages and is driven by the turbine. The air leaves the compressor at an absolute pressure of 32.4 lb per sq in., and passes to the heat exchanger, where it absorbs heat from the turbine exhaust. Thence it flows to the combustion chamber, where, by the combustion of the gas oil, it is heated to the highest temperature attained in the cycle, and from which it passes to the turbine, where the resultant gases of combustion expand. After expansion, the gases return to the heat exchanger, are cooled by the transference of heat to the fresh compressed air, and eventually are discharged through the exhaust duct.

The fuel pump is of the six-cylinder Bosch type, as used for Diesel engines, but having the six deliveries combined in a common pipe leading to the burner, which is also of Bosch construction. With the speed governor and the lubricating-oil pump, it is driven by means of worm gearing from the compressor shaft. The fuel is ignited in the combustion chamber by means of a high-tension transformer and a spark gap situated close to the burner nozzle. An electric motor, connected to the compressor shaft by a belt, is used to start the unit. The present tests sufficiently indicate the possibility of constructing combustion turbines of the type described which should equal, and perhaps surpass, the efficiency of the Diesel engine, and provide a new form of motive power offering appreciable advantages.

Opposed-Piston Diesel Engine

THE OIL ENGINE

DURING JULY, 1938, the first 500 bhp, 1500 rpm, two-stroke opposed-piston Diesel engine for rail-traction use was built and tested by La Compagnie Lilloise de Moteurs of France. Because of the success of these tests, additional

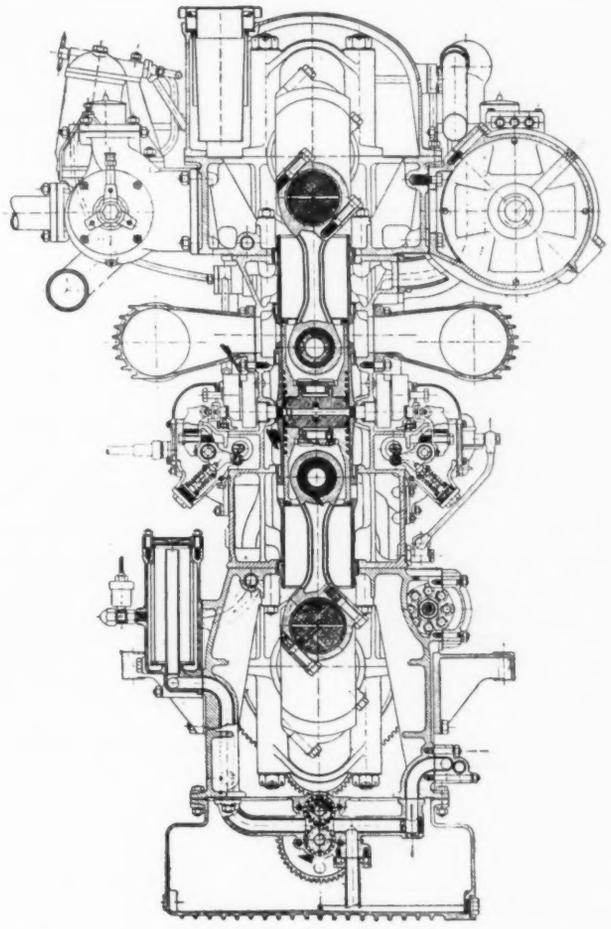


FIG. 5 CROSS SECTION OF C.L.M. TRACTION-TYPE OPPOSED-PISTON DIESEL ENGINE

engines have been constructed and placed in actual service. The following description is taken from the January, 1939, issue of *The Oil Engine*.

As shown in Fig. 5, the engine is of the vertical, twin-camshaft type with eight cylinders, each containing two light-alloy pistons. The upper piston in each cylinder controls the exhaust ports, while the lower piston governs the air-inlet ports. The two crankshafts are connected together by a train of gears. Air for scavenging and recharging the cylinders is supplied by a centrifugal compressor driven from one of the intermediate gears in the gear train. An aluminum alloy is used for the main castings of the engine, namely, the bottom crankcase, the cylinders, and the top crankcase. Crankshaft

TABLE 1 SPECIFICATIONS OF C.L.M. OPPOSED-PISTON DIESEL ENGINE

Horsepower	500 bhp
Cylinders	8
Pistons	16
Normal speed	1500 rpm
Cylinder bore	4.72 in.
Piston stroke	2 × 5.9 in.
Weight (dry)	4640 lb
Length	7.32 ft
Width	2.20 ft
Height	5.31 ft
Weight per bhp	9.3 lb
Piston speed	1480 fpm
Mean effective pressure	79 psi
Injection pressure	3000 psi
Compression	226 psi
Fuel consumption—full load	0.423 lb per bhp-hr
Fuel consumption—half load	0.482 lb per bhp-hr

bearings have lead-bronze bushings and the piston pins operate with needle roller bearings. There are two sets of eight C.L.M. injection pumps, one on each side of the engine, providing two pumps for each cylinder. Specifications of the engine are given in Table 1.

Creep of Steel

THE BROWN BOVERI REVIEW

MANY phases of the subject of the creep and recovery of steels at high temperature are considered in an informative review, based on the work of many investigators as well as that carried out at the material-testing laboratories of Brown, Boveri & Company, Limited, Baden, Switzerland, published in the December, 1938, issue of *The Brown Boveri Review*.

After pointing out that great progress has been made in recent years in the development of special steels for use at high temperature, the effect of alloying for the purpose of attaining a high creep limit is discussed. The importance of molybdenum, it is said, was grasped at an early date, and steels of the chromium-molybdenum and chromium-nickel-molybdenum types, hardly known 10 to 12 years ago but commercially available today, are recognized as having high creep limits even at 500 to 550 C. Examples, including alloys containing tungsten, are tabulated.

In addition to alloying, it is shown that age hardening offers other possibilities of improving the creep limit. Moreover, in practice it is noted that the degree of forging or rolling of the material has considerable influence on the creep limit, and that heat-treatment, below the equicohesive temperature, also plays an important part. What these various effects amount to quantitatively are disclosed in tabulated test results.

The article next discusses the measurement of creep values, the precision of which is necessarily not very high, and the numerous testing methods, divided roughly into long-time and short-time types. It is pointed out that very long-time tests cannot be utilized in practical engineering, such, for example, as tests of 1000 hr duration. The evaluation of creep-test data, therefore, has to take into account the way in which the results were arrived at. It is shown that the somewhat greater unreliability of the 40 to 50 hr test is amply compensated for by using only two thirds of the creep limit thus determined as allowable stress. At this admissible stress, the creep rate is not only much lower but the overload capacity of the steel is much better.

Nevertheless, it is stated, the test of 1000 hr duration is indispensable for making studies and for gathering information. Here the way in which results are plotted is of importance in order to allow of a correct estimation of elongation and rate of creep. A probable elongating about 1 per cent in 10 years is found for a load corresponding to the creep limit, determined by a 42-hr test.

The conditions of an ordinary creep-limit test are often, in practice, it is said, affected by other influences exercised on loaded parts of machinery. The influence of several repeated loads and unloadings with pauses between is of especial interest. These conditions and especially the periods of recovery have been studied, the pauses being partly at 500 C and partly at 25 C.

The rôle played by creep recovery has only lately been studied with care. After unloading a test piece which has been under load for a long time at high temperature, a general contraction is noted, which, however, never attains the amount of preceding creep elongation. When successive loading and unloading is resorted to the creep and creep rate diminish rapidly with each new load and similarly to an interrupted creep-limit test. The unload pauses at 500 C show, however, a somewhat greater resulting elongation than the pauses at 25 C.

The work hardening of steel, it is said, was maintained at 500 C, and the recovery contraction takes place not only with pauses with temperatures maintained at 500 C but also with pauses during which the test piece is cooled to 25 C, and this in about the same measure. From these results certain conclusions concerning the plastic behavior of metals are discussed, and it is pointed out that the recovery effect can be explained as an effect of the grain-boundary substance, caused by the different speed dependence of the translational deformation of the crystals and the viscous plasticity of the intercrystalline layer.

The practical application of these results, it is said, leads to a differentiation between the life of a machine part inclusive of no-load and partial-load periods and the effective duration of the stress at full load and maximum temperature. Referred to the length of life, there are considerably smaller elongations, as a result of varying loading and unloading in service, than could be expected from the uninterrupted long-time creep test. If, however, reference is made to the effective duration of the load, the elongations are at a maximum equal to those of the standard creep test.

Built-Up Crankshaft

ENGINEERING

CRANKSHAFTS for large stationary and marine internal-combustion engines have been constructed in sections to overcome difficulties in casting and forging. However, such built-up crankshafts for automotive and aircraft engines have not been found practical because a sectional shaft involves a marked increase in weight. Now, Dr. Albert Hirth, of Stuttgart-Zuffenhausen, Germany, has introduced a method which results in a shaft of comparable weight with one machined from the solid. The method of construction is described and illustrated in the Feb. 10, 1939, issue of *Engineering*, from which the following abstract is taken.

The several forgings constituting the complete shaft are of such a size and form that they can be drop-forged with plain dies in small or medium-sized presses, thus insuring sound forgings at a relatively low cost. Further advantages of building up the shaft are that any component part can be replaced at small cost in the event of damage, and that such replacement does not involve the regrinding of the bearing journals and refitting of the bearings throughout. Because of the subdivision of the shaft, tough high-tensile, heat-treated material can be selected for the webs, and suitably selected and heat-treated material for the crankpins. With the conventional type of

crankshaft, a spiral type of split roller bearing is required, in conjunction with split connecting rods, but these difficulties are overcome if the crankshaft is of the built-up type. The roller bearings permit the shaft to be run at speeds up to 8000 rpm, if desired, and it is possible to mount a gear wheel at any point on the shaft for auxiliary drives.

The crankpin can be joined to the webs by a number of alternative methods, but in all cases the adjacent faces are cut in the form of the male and female members of a multiple-tooth dog

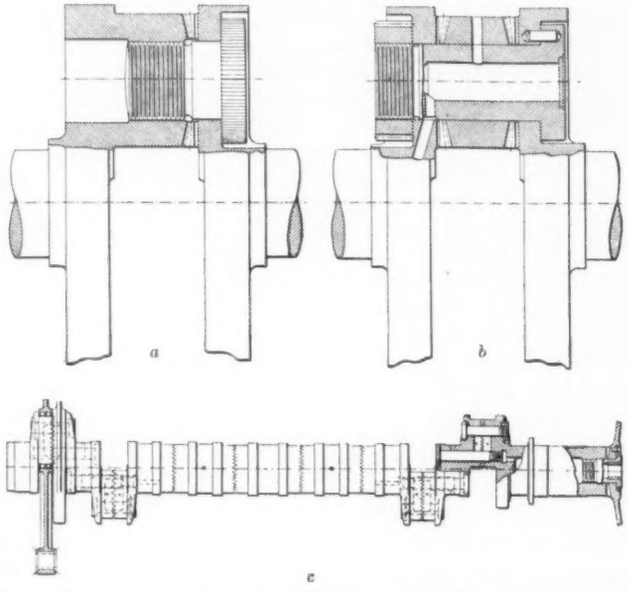


FIG. 6 BUILT-UP ROLLER-BEARING CRANKSHAFT AND TWO METHODS OF ASSEMBLY

clutch or coupling. In this method of assembly, the pins are forged in one piece, with one or other of the adjacent webs, so that only one coupling is necessary for each bearing. A method of connection that can be adopted when this practice is employed is illustrated in *a* of Fig. 6, the two webs being connected by a shouldered tap bolt engaging with an internal thread in the crankpin. Another method of assembly is shown in *b* of Fig. 6, a bolt and nut, with a suitable locking device, being employed in this case in order to hold the three parts together.

An important feature of the design is that the torque on the shaft is transmitted by the clutch teeth, the stud or bolt being merely in tension. A shaft for a 16-cylinder car is shown in *c* of Fig. 6. It will be seen that in this shaft, each half of the crankpin is formed integral with an adjacent web, the two halves being held together by an outer bolt and nut, and an inner tap bolt.

It will be evident that this method of joining parts of sectional crankshafts has various other applications, such as the mounting of spur gearing on shafts and the simplification of castings by building the latter up from component parts. A particular example that might be quoted is the subdivision of long camshafts, thus simplifying both the machining and hardening processes.

The number of teeth that may be used on the coupling varies with the size of the work. It is usually some multiple of 12, and the teeth may have either two oblique flanks, or one straight and one oblique flank. The flanks can be loaded up to 10,000 psi, when the load is steady, or up to 7000 psi when the load is vibratory or fluctuating. The teeth are normally cut on a vertical miller, and may be subsequently ground if an exceptional degree of accuracy is required.

Welding High-Tensile Steel

THE INSTITUTION OF MECHANICAL ENGINEERS

HIGH-TENSILE structural steels generally contain relatively small additions of alloying elements which affect their welding properties because of hardening effects, according to T. B. Wilkinson and Hugh O'Neil, who describe their observations on the arc welding and gas cutting of high-tensile low-alloy structural steels in a paper which was sent out for discussion in March, 1939, by The Institution of Mechanical Engineers (Great Britain). Mechanical properties of certain well-known high-tensile steels containing additions of manganese, manganese chromium, and nickel are shown in a series of tables, together with their tensile-test values in the form of metallic-arc-welded joints. The weldability, i.e., the ease of producing joints free from dangerous characteristics, of these steels has been studied by means of special cracking tests, and the factors which affect weldability are discussed.

The factors which are involved in the production of single-run fillet-weld cracks are: (1) degree of restraint imposed upon components to be welded, (2) initial temperature of components, (3) chemical composition of components, (4) method of manufacture of steel and freedom from alloy segregation, (5) thickness of components, (6) relative size of weld bead to plate thickness, (7) speed of welding, (8) size of electrode, (9) characteristic of electrode wire and coating, (10) current input, (11) freedom of parent plate and weld metal from nonmetallic inclusions, and (12) welding sequence.

Some of these factors, such as (5) to (8), are related to each other, and in effect cause relative fillet size to be the important consideration.

The remedies proposed by the authors to reduce weld cracking in high-tensile steels may be summarized as follows: (1) Limitation of carbon content of steel to 0.15–0.20 per cent, where tensile requirements permit, (2) preheat components to 400 F or more before welding, (3) adopt slow speed of welding, e.g., about 7 in. per min, maximum, (4) apply one or more annealing runs immediately after the first run, (5) use of soft mild-steel welding rods, (6) use of austenitic welding rods, and (7) introduction of an inhibiting element, e.g., titanium.

The principle of employing austenitic welding rods is to deposit a protective metallic layer of lower thermal conductivity than that of the material to be welded. The part is then annealed to eliminate any brittle zone which may have formed between the austenitic deposit and the parent plate. Components are next reassembled and the final joint made with an austenitic rod which will now have no opportunity to produce a quench-hardened zone. However, the authors do not recommend this method because of the greater cost of the rods. The fillet size for the plates considered should in general be not less than half the thickness of the plate, and the importance of the most suitable welding sequence in relation to weld stressing must always be considered.

The properties of 11 different high-tensile and mild-steel covered rods were studied and it was concluded that the selection of the correct electrode is limited by practical utility. It was shown that a rod of soft mild steel with a coating of iron oxide, siliceous matter, and white asbestos spiral winding, has oxidizing effects, but produces welds free from cracks under severe cooling conditions. It is associated with low tenacity and operating difficulties, however, and is recommended only in cases of extremely high cooling rates of the weld. In general, mild-steel rods, containing 0.18 to 0.4 per cent carbon, 0.27 to 0.05 silicon, and 0.46 to 0.19 manganese, are recommended.

Hardness tests do not necessarily give a true indication of the brittleness and liability to cracking of the zone of thermal dis-

turbance in a weld. It is suggested that one reason for this is the incidence of different austenite transformation temperatures for different welding conditions, leading in some cases to "delayed quench" effects. Under the most severe circumstances preheating the plates to 400 F or more, and arranging for slow cooling, enables a sound joint to be produced.

Structures to be welded are frequently prepared by flame cutting to the required size and shape, and this process proceeds in a normal manner with low-alloy steels, though they seldom give cut edges as soft and as easy to bend as those of mild steel. If great care is taken it is reported that quite "difficult" high-tensile steel may be successfully flame cut, but the problem of hardened edges must be borne in mind. As in welding, the cooling conditions behind the high-temperature fusion zone determine the metallographic constitution of the steel at the edge, and the factors governing soft welds bear some relation to those giving ductile cuts.

The main factors governing the softness of the cut edge are: (1) Chemical composition of the plate. Unpreheated plain carbon steels should not have more than 0.30 to 0.35 per cent carbon to avoid "crazing;" (2) composition of the fuel gases used; (3) burner adjustments; (4) speed of cutting (for a given gas supply this is inversely proportional to the plate thickness); (5) dimensions of plate, especially thickness; and (6) preheating or postheating of the steel.

Gas-cut edges of these steels are liable to be hardened and "crazed" and of low ductility because of quenching effects. The use of oxy-coal gas with a relatively slow speed of cutting and ample jet size enables satisfactory cuts to be made. Bend tests on a plain manganese high-tensile steel and a manganese-chromium high-tensile steel after gas cutting indicate differences in ductility. Removal of the hardened edge by grinding leaves a satisfactory plate.

Designing and the Designer

TEKNISK UKEBLAD

AN EDITORIAL in the Jan. 5, 1939, issue of *Teknisk Ukeblad*, a technical journal of Norway, discusses at length two articles on designing and the designer, which appeared in the *V.D.I. Zeitschrift*, numbers 13 and 38, 1938. Since the editorial contains thoughts which are of interest to engineers, educators, and students, the following translation from the Norwegian, slightly abbreviated, was made by K. W. Frederiksen, of Brooklyn, N. Y.:

It is a fact that young engineers, at present, have very little inclination to become designers because this type of work, from an engineering viewpoint, is often thought of as being of secondary importance. This attitude may be attributed to impressions gained in school and in industry. Expanding this idea further, it is seen that:

1 The treatment given in college to the teaching of constructive form and development is very poor so that the student's appreciation and respect, in the strict sense of the word, for this essential and really creative phase of engineering is not sufficiently stimulated.

2 Industry itself fails to recognize the importance and merits of designing. There is a definite lack of understanding about design and a neglect in proper appreciation of how much this constructive and creative faculty adds to the assets of industry.

Designing is the coordination of science and art and should be regarded in relation to the work of the scientist and artist. The task of the designer, paralleling that of the artist, is the materialization of an idea. It is often reasoned that the originator of the idea is the one who should reap the benefits and be given the honor for the results which are eventually achieved, since the development of the idea into workable form requires merely some mechanical skill.

In technical design, the designer is often given an idea and requested to develop something along the lines indicated. However, until he can solve the problem satisfactorily, several other ideas have to be tackled by him before the correct answer to the original idea can be found. In other words, brilliant ideas are often advanced without due thought being given to the many major problems which must be met before the original idea can be completed. This does not facilitate matters for the designer, but, on the contrary, makes his work more difficult. The original idea and all the other ideas must be compared and their solutions analyzed and appraised. In spite of all this, the designer, doing the same creative work as a scientist or artist, does not get credit for his work. There is great disproportion in the valuation of their tasks, which are similar in character. Perhaps it is the fault of the designer himself, but industry is not entirely blameless for this condition.

If the designer is to assume his rightful position in the order of things, how should he be educated and trained? The first point that should be presented to the embryo designer—and one which should be stressed continually throughout his educational and training period—is the absolute necessity for attention to details. This habit, if started in college, usually carries through into practice, and may be said to characterize the prominent designer. In this respect, there is resemblance between him and the great artist. Furthermore, this is directly opposite to, and refutes the theory that, "the original idea is the main thing." This care for detail eliminates slipshod thinking and trains the designer to recognize essential and nonessential ideas branching out from the main idea and to tackle these problems in an orderly and efficient manner.

The principal requirement which must be met by college courses is the need for instruction in the fundamental principles. That is to say, each separate course should be so planned that the main stress is put on the basic elements. The greatest value a student obtains from such a course of instruction is a complete understanding of these elementary principles. Lacking this absolutely necessary knowledge, a student exposed to advanced courses is apt to develop a blurred image. He will, in all probability, emerge from college with a mind filled with a kaleidoscopic array of facts, rather than one in which each fact appears as a clean-cut picture. Special theoretical knowledge in this stage of the game is more or less without value, since research rapidly outdistances and renders obsolete texts and teachings in these fields.

The instruction in machine design should be concentrated on theory and computations relating to development and dimensioning of elementary machines and engines. It may sound strange, but it is the theorist more than the practical industrial engineer who has most value as a teacher in machine design. It is a matter of small importance to, and one that imposes no severe handicap on, the student designer who is not acquainted with the multitude of variations and modifications found in every branch of machinery and with which, of course, the specialist in any one branch is thoroughly familiar. This kind of knowledge is easily acquired when the need presents itself. The elements of design, however, must be acquired by the student during his formative period of instruction; if not, they will never have their proper place in later years. Remember, no fully trained engineers are ever graduated from a college.

What can industry do in order to stimulate a designer's productivity? A contributor to the *V.D.I. Zeitschrift* writes, "The management can help out here. Often there are only complaints and criticisms, never a word of appreciation. There is much room for improvement right here."

In the first place, it is the duty of an alert management to encourage spontaneous design and to keep an open mind as to the desirability of having a good designer on the staff; then, to evaluate him as such, taking into consideration his technical ability by paying him in accordance with his status. Nowadays, it seems as if a large number of graduate engineers want to go into industry in the capacity of sales engineers, feeling that this branch is better paid and on a higher social plane. It might be advantageous to industry from a national economic point of view, if it could make the work of designers more attractive as well as more remunerative.

Telegraph Industry

NEWCOMEN SOCIETY

IN 1944, said R. B. White, president, The Western Union Telegraph Company, in a paper "Telegrams in 1889—and Since," read at a dinner on Feb. 16, 1939, under the direction of the New York committee of the Newcomen Society (American branch) for the Study of the History of Engineering and Technology, we shall celebrate the one-hundredth anniversary of the introduction of the first simple recording telegraph of Samuel Morse. Speaking of the future Mr. White said:

It well may prove that we are being literally "kicked up stairs" under stimulus of necessity to meet competition, ever-growing taxes, and multiplicity of expanding operating expenses to which labor costs and attendant social-security taxes contribute a formidable share; the telegraph industry now is engaged in one of the most comprehensive engineering programs of its existence.

This program falls into four main categories:

The first is extensive development of what now are known as carrier or superimposed circuits, by means of which a pair or a relatively small number of wires or cable conductors may be made to carry a large number of separate channels of communication.

The second is extension of automatic switching between circuits connecting various cities and between central offices and customers, so that direct communication will be effected quickly and without necessity of copying, relaying, or retransmission as practiced generally today.

The third is wider application of the varioplex, which made possible the creation of a service known as telemeter. The varioplex automatically divides the total "word capacity" of a multichanneled single line among a number of subscribers. Each pair of subscribers employs one of the subchannels and is in direct communication simultaneously. Total circuit capacity is at all times equally divided among those who are actually using it at any time; in this way, the idle channel time of each customer is automatically placed at the disposal of other subscribers. The advantage is self-evident.

The fourth is widespread application of the much-discussed system of automatic facsimile telegraphy, permitting transmission and delivery of exact duplicates of the original "copy," be it picture, printed matter, or whatever else.

Looking into the future, we easily can visualize what these basic developments portend: Carrier circuits and the varioplex will enable the telegraph industry to utilize its present wire plant without addition and serve the telegraph needs of the nation for many years to come. Automatic switching will provide a tool greatly accelerating business and industry. Facsimile not only will completely eliminate errors in transmission, but, like automatic switching, will provide added speed and convenience to telegraph service. Introduction of facsimile telegraphy provides abundant opportunity for exercise of one's imagination. It is conceivable its use even may change our present news-distribution system; or even the method and manner of printing newspapers themselves.

Rubber Wrapper for Foods

INDUSTRIAL BULLETIN OF ARTHUR D. LITTLE, INC.

THE latest transparent food wrap, according to the *Industrial Bulletin of Arthur D. Little, Inc.*, is rubber, and it has fulfilled its principal purpose long before it reaches the retailer's shelves, with its sales appeal "purely coincidental."

The name "Cryo-Vac" will be recognizable to our classical race of food venders as possibly meaning "cold and empty." Such an unorthodox trade name is descriptive of the history of the new wrap before it is put on sale. In its original form it resembles a deflated, wide-mouthed toy balloon. It is blown up, however, by stretching the wide mouth over a frame and drawing a vacuum around the outside. It thus takes the shape of the cylindrical container into which it has been drawn—and the chilled sides of the container "freeze" it into the larger size. Into such an open-end package is dropped a broiler; a vacuum hose removes the inside air and draws the wrap close to the contents; then the neck of the balloon is twisted and clamped to make the whole vacuum pack airtight. Then comes the trick—the package is immersed in warm water to "thaw" the balloon; it attempts to shrink to its original size, and stretches to a taut, transparent wrap around the plump chicken.

Various potential advantages for such a food container are obvious, and Dewey and Almy claim to have realized many of them without most of the possible objections. A special latex rubber was necessary, with no sulphur. Special equipment was designed to reduce the handling time in packaging to a point well below that for many other wraps. Formulas and production technique developed in the manufacture of latex sounding balloons were required for the necessary low cost, strength, etc. Incidentally, in the chilled, expanded form, the rubber has surprisingly great strength. Most of the advantages claimed are due to the elimination of air or to the complete moisture tightness. Pork products, for example, are said not to develop rancidity in the fat, chickens to show no "freezer burn," the bane of low-temperature preservation of poultry. Prevention of moisture loss not only preserves the original weight, but reduces frosting of cooling coils in the refrigerating units, and increases their freezing efficiency.

Bags for poultry are designed as one-trip containers to be removed by the consumer. Larger bags are intended for the storage of seasonal surpluses of green hams, pork loins, etc., which are temporarily frozen and released for the market as needed. For these purposes, the latex bags can be washed, shrunk, and reused several times. The largest bags are being designed for use with quarters of beef, veal, and lamb carcasses, and are expected to find their principal market in the export field. A bag for a 350-pound side of beef is said to be a practical possibility.

The new wrap is still in the introductory stage, with several interesting possibilities being tried experimentally. In one trial, carbon dioxide replaces the air in the sack, possibly obtaining the benefits claimed for storage in that gas without the usual special storage equipment and cost. In others the sacks are used to protect the meats and vegetables during freezing by spray, air blast, or immersion. Sides of beef hung in them are said to show reduced loss from mold, without restraining the enzyme action that produces prime beef. It is expected that the principal packer attention will be directed to trials with pork products and that first application to be noted by consumers will be on poultry and fish.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Fatigue and Corrosion Fatigue of Steels

To the Editor:

The editor is to be commended for selecting for publication the timely paper on "Fatigue and Corrosion Fatigue of Steels."[1] The author has packed within this relatively short article most of the important information on this vital subject necessary to bring those of us who "read while we run" up to date. This summarized presentation naturally stimulates interest in related problems.

In his discussion of Dr. de Forest's paper on "The Rate of Growth of Fatigue Cracks,"[2] the writer described a situation, continually recurring, in which the question of salvage of parts subjected to alternating stresses becomes important. For example, when fatigue cracks are found in a number of steam-turbine blades in a given row, the problem arises as to whether or not the remaining blades are to be condemned.

In this particular case, a year or more may elapse before another opportunity is afforded to inspect the blades, during which time they may be subjected to additional stress-reversal cycles, of the order of 3×10^9 or more, of uncertain intensity. The cost of renewal may run into several thousand dollars and, while there is a natural hesitancy to discard apparently sound blades, there is apprehension that cracks may initiate and progress to failure before the next inspection. The absence of even minute cracks in the remaining blades is fairly assured by means of the Magnaflux crack test, but it is quite impractical to make a detailed examination of the microstructure for evidence of slip lines in the grains, even if such evidence were dependable.

The question the writer poses is: Can the blades or similar parts be reconditioned by heat-treatment, or other means, so that the history of stress reversals already chalked up can be obliterated and the clock set back to zero? The writer would be interested to know of any research carried out to explore this question.

Speculations as to the actual rate and method of propagation of the crack are interesting. If the penetration is continuous after the initial slip stage, advancing with each reversal cycle, the increment of advance for each cycle to result in a growth of one tenth of an inch in a million cycles for example would be of the order of one ten millionth of an inch. This is getting down to molecular dimensions, and is suggestive of pole slipping in synchronous generators.

The writer would be interested in learning whether any fatigue-test program has included tests on chrome steels subjected to conditions producing carbide precipitation, in which the intercrystalline conditions might conceivably alter normal crack propagation.

Although the fatigue limit appears to be definitely related to ultimate tensile strength rather than to the yield point, it would also be of interest to know of any tests carried out on "Austempered" steels, as compared to the same steel with the usual heat-treatment.

Almost all the fatigue investigations appear to have been made on the rotating-beam machine: Is there any information available as to any appreciable differences obtained by imposing purely linear unidirectional rather than rotating stress on the beam?

Thomas C. Rathbone.[3]

To the Editor:

Mr. Rathbone's kind remarks are much appreciated. The paper, which was not originally intended for publication, makes no pretense beyond a review of published data to bring, as he so aptly phrased it, "those of us who 'read while we run' up to date." Mr. Rathbone raises the question as to whether heat-treatment will obliterate the effects of fatigue. In reply, an opinion is offered

TABLE 1

Property	1.25% Manganese steel	3% Nickel wrought iron
Chemical Composition: (per cent)		
Carbon	0.360	0.030
Manganese	1.170	0.040
Phosphorus	0.024	0.077
Sulphur	0.021	0.027
Silicon	0.190	0.110
Nickel		3.000
Slag		2.750
Static Physical Properties:		
Yield point, lb per sq in.	71,300	58,100
Tensile strength, lb per sq in.	100,000	63,900
Elongation, per cent in 2 in.	28.8	31.0
Reduction of area, per cent	63.9	50.2
Charpy impact strength, ft-lb	34.6	24.0
Brinell hardness	206	149
Condition	hot-rolled	hot-rolled
Endurance Properties: (lb per sq in.)		
Reversed bending	48,900	42,600
Reversed axial	45,800	39,500
Unidirectional axial (0 to maximum)	67,200	58,000
Notched Endurance Properties:[a] (lb per sq in.)		
Reversed bending	16,900	16,900
Reversed axial	17,500	16,800
Unidirectional axial (0 to maximum)	26,800	25,600
Stress-Concentration Factors:[b]		
Reversed bending	2.89	2.52
Reversed axial	2.62	2.35
Unidirectional axial (0 to maximum)	2.51	2.26

[a] Notch was 60 deg groove with a radius of 0.0065 in. at root. Ratio of depth of groove to diameter of specimen was 0.10.

[b] Ratio of fatigue limit of unnotched specimens to fatigue limit of notched specimens.

[1] By Blaine B. Westcott, Mechanical Engineering, November, 1938, p. 813.

[2] *Journal of Applied Mechanics*, Trans. A.S.M.E., vol. 58, 1936, pp. A23–A25. Discussion p. A-114.

[3] Chief Engineer, Turbine Division, The Fidelity & Casualty Co. of N. Y., Philadelphia, Pa. Mem. A.S.M.E.

that such treatment might be beneficial only when slippage has not progressed to the point of permanent rupture of atomic bonds and the formation of microscopic cracks, the detection of which probably would be impossible. The author knows of only one commercial attempt of this kind. It was not successful but it may have been due largely to the fact that the company which offered this service had no control over the period or severity of operating conditions prior to the application of the reconditioning heat-treatment. This question should give rise to much interesting speculation.

The author is not familiar with any data that would answer Mr. Rathbone's questions about the effect of carbide precipitation during service on the rate of crack propagation or about the fatigue properties of steels after the usual heat-treatment as compared with "Austempered" treatment.

In Table 1 are a few hitherto unpublished data giving a comparison of fatigue limits as determined for reversed bending (rotating beam) stresses and for unidirectional axial stresses.

BLAINE B. WESCOTT.[4]

Quantitative Analysis of Process Lags

TO THE EDITOR:

Mr. Mason's paper[5] is a welcome contribution to the too scanty literature on the types of heat transients presented by continuous-process and similar problems. His plea that hydraulic-analogy concepts be adopted for purposes of interpretation, visualization, and clarity of understanding, should meet with open-minded consideration. One cannot work a problem until it is understood and formulated. The refusal of heat quantities to be directly, physically sensed, obscures their understanding for many people. Yet these same people can grasp the ideas involved, once hydraulic quantities are substituted for heat quantities. The next result is that the understanding of the hydraulic quantities enables the imagination to visualize the otherwise mysterious heat quantities themselves.

It should be clearly understood that as long as problem solutions are attained only by mathematical tools, the only purpose of the hydraulic analogy is to give clarity and understanding. But the present writer became convinced some years ago, that mathematics as a tool is of too limited usefulness in the field of heat transients. Mathematics beautifully solves the simple problems, and, therefore, furnishes indispensable basic solutions which are of great use—as far as they go. However, too many of our practical engineering problems, while simple enough in a physical sense, are yet sufficiently complicated to call for complex mathematical attacks that are quite impractical as working tools.

The writer not only thinks of heat transients in terms of the hydraulic analogy, but also uses the analogy for solving the problems. The writer's Hydrocal, under development for some years, consists of a number of adjustable liquid capacities, a large battery of calibrated flow tubes of different resistances, a number of tanks of adjustable level, and an adequate arrangement of manifolds, connectors, and shutoff mechanisms to permit of reasonable speed in setting up problems and running them off. The latest and most complete design of this new hydrodynamic-type computing machine is under construction, and may be completed within the present year.

If the physical situation has multiple capacities that affect the heat transient, such capacities should be taken into account. With 18 standpipe positions (or liquid capacities) and corresponding sets of tanks, flow tubes, manifolds, and operating mechanisms, the Hydrocal can be set up to take such capacities into account.

Moreover, the instrument is designed to operate slowly enough so that the solution of a transient can be watched, recorded in transit, and also frozen in its tracks for any length of time before starting up again. The ability to freeze the transient at any point means that many types of changes can be imposed at will, thus making available the solutions of problems that would be hopelessly difficult or time-consuming if approached otherwise. The Hydrocal was described in the June, 1936, issue of *Industrial and Engineering Chemistry*, Vol. 28, page 704.

A. D. MOORE.[6]

How Useful Is Your Sense of Proportion?

TO THE EDITOR:

The keynote to the paper by Mr. Johnson[7] is the value of experience as leading to the exercise of judgment or "horse sense" in designing machinery. It is a point, however seldom it is expressed or thought of, well worth consideration. An old experienced designer or mechanic makes things a certain size to accomplish a purpose expressed in a problem which is before him and he judges it "ought to be about so." This illustrates the point contained in the paper that by long-continued experience and practice, men acquire a sense of proportion whereby they automatically arrive at proper sizes in the equipment which they are designing.

This is illustrated by an experience that I had in designing a complete line of turret lathes. After making the general drawings showing sections, I made a set of detailed drawings which were correct or rather actual in size for the middle size of the machines and used letters for the dimensions. I then made a table in which I put the dimensions for all five sizes of machines, two larger than the one actually detailed and two smaller. These machines came out fine samples of designing in which there were few necessary changes as to details. They were made to my design for about twenty-five years without material change.

ELMER H. NEFF.[8]

Exposure Tests on Plywood

TO THE EDITOR:

The information contained in this paper[9] is the first comprehensive analysis of comparative results obtained on various adhesives under extreme weather exposure. The data are particularly valuable at this time when the interest in the use of plywood for prefabricated-housing projects is so active.

The results given in this paper show clearly the great advantage of hot-pressed resin and blood-albumin glues, as compared to casein and the less valuable conventional glues. It is the writer's conviction that the graphic presentation of these facts will do much to stimulate the use of plywood in the construction industry. The variety of tests is sufficiently comprehensive to meet almost any practical service as in concrete forms, buildings exposed to the weather, building exposed to the action of sea water, the building of boats, and the construction of box shooks required for export transportation.

The writer wishes that it had been possible for the author to give a more complete description of the four resin ad-

[4] Gulf Research & Development Company, Pittsburgh, Pa. Mem. A.S.M.E.

[5] "Quantitative Analysis of Process Lags," by C. E. Mason, Trans. A.S.M.E., May, 1938, p. 327.

[6] Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich.

[7] "How Useful Is Your Sense of Proportion?" by W. E. Johnson, MECHANICAL ENGINEERING, June, 1938, pp. 481–484.

[8] Manager, New York office, Brown & Sharpe Mfg. Co. Life Mem. A.S.M.E.

[9] "Exposure Tests on Plywood," by Don Brouse, MECHANICAL ENGINEERING, November, 1938, pp. 852–856.

hesives indicated as P-1, P-2, P-3, and P-4. There are a number of hot-pressed resins in use at the present time, some with a phenolic base and some with a urea base. Still further, in some cases these are delivered by the manufacturer in liquid form, and in other cases in film form, and possibly also in powdered form. There is undoubtedly a difference between the durability of phenol and urea resins, and probably there will be discovered some further difference between those that are applied as a liquid, and those that are interleaved as a film.

The hot-pressed bonding of resin adhesives is rapidly growing in this country, and in the last 5 years, to the writer's knowledge, over 75 hot-press installations have been made. It would seem therefore desirable to have as much further detail regarding the character of these resins as can be presented in public form.

There is no more impartial and adequate source of information about materials of this kind than the Forest Products Laboratory at Madison, Wis., which has behind it a broad experience in the use of various plywood adhesives, and has developed a recognized attitude of impartiality which makes its findings thoroughly dependable.

THOMAS D. PERRY.[10]

Synthetic Substances With Rubber-Like Properties

TO THE EDITOR:

Mr. Bridgwater's paper[11] goes a long way toward clarifying our thinking in regard to synthetic rubber-like substances. We agree with him that it is next to impossible to make even a general comparison between the commercially available products.

The fact that these rubbers resist deterioration by gasoline, oils, greases, and solvents is of interest to engineers. We agree that in evaluating these either service tests or tests approximating the conditions of service are the most reliable ones to use.

However, laboratory tests can be quite helpful in determining broadly what solvents seriously affect these rubbers, and the conditions under which they are affected. One would hardly wish to run service tests on a paint spray hose if laboratory tests showed the rubber to be seriously affected by paint or lacquer thinners. Again the degree that the rubber-like material swells is unimportant if swelling is not a factor in service. It becomes important if swelling is a factor. A great many articles are made to exact dimensions which require that little or no swelling take place in service. Here swelling tests are of value for determining whether or not a given rubber is suitable for a specific application.

We are told that the synthetics are more durable in sunlight than is natural rubber. Rubber compositions to be sun-resistant do not necessarily have to be oil-resistant and in this case relatively high percentages of natural rubber can be blended with certain of the synthetics and still maintain good sun resistance. This is true in the case of the polysulphide rubbers.

Mr. Bridgwater is correct in his statement that the alkylene polysulphides, or as we prefer to call them, the polysulphide rubbers, have elasticity comparable to natural rubber under momentary distortion, but suffer some plastic flow under a sustained load. Because the polysulphide rubbers undergo a certain amount of cold flow under heavy loads, does not necessarily mean that they cannot be used for a given job where freedom from permanent distortion is a factor. This can quite frequently be taken care of by compounding, by design of the part, or through the use of reinforcing members such as fabric.

Under the section relating to chemical resistance, he states that the polysulphide rubbers will not stand alkalies. "Thiokol" type A is attacked by alkalies, but not "Thiokol" type D or type DX.

The American Society for Testing Materials, Rubber Manufacturers Association, the various government bureaus, and other consumer groups are struggling with the problems of specifications and testing methods for these synthetic rubber-like materials. It is a knotty problem. Specifications are often written around tests that are far from throwing a true light on the serviceability of the rubber. Mr. Bridgwater has ably pointed out the fallacy of writing specifications around tensile strength, yet this is a commonly used test. An illustration will serve to amplify this point. Natural rubber, chloroprene rubber, and butadiene rubber can be compounded to give tensile strengths much higher than can be obtained with a polysulphide-rubber stock. Yet, if these same four stocks are allowed to stand in contact with gasoline for a short length of time, and then tested while wet, the polysulphide stock may have the highest tensile strength of the lot.

Mr. Bridgwater has done an excellent job of pointing out to us the factors that enter into a proper evaluation of these synthetic substances. In his conclusions he gives us a good rule to follow in picking the material for a given job: Analyze the conditions of service; get a material approaching the ideal; and test under service conditions.

S. M. MARTIN, JR.[12]

Control of Dust Explosions in Industrial Plants

TO THE EDITOR:

In considering dust explosions[13] it is not improbable that the importance of static electricity may frequently be overlooked. The author has touched upon its generation, but only in such apparatus as may be away from the dust phase itself. Many dusts are hygroscopic, and when confined in a duct or container may rob the air of moisture and lower the relative humidity to a point favorable to static generation. When such dusts are in air-borne motion, as in a duct, there may result a frictional interrelation between the air stream and the dust particles which could build up a considerable voltage.

The writer has under observation an 11-in-diam duct, some 1200 ft long, which conveys large amounts of wood dust and flour in air suspension at a velocity of about 7200 fpm. The dust originates from thoroughly kiln-dried woods, and is of all sizes ranging from coarse shredder stock through shavings and sawdust down to flour particles of 2 or 3 microns. It has been frequently noted, quite especially in the clear and dry days of winter, that static potential of the order of 3000 volts can be indicated at the delivery end of the 1200-ft run upon a voltmeter connected between the center of the air stream and the duct itself. Of especial importance is the observation that careful bonding of all duct joints with soldered copper straps and their grounding to earth will not drain off all of the charge, from which it would appear that the dust particles either fail to touch the duct interior or else they do not completely yield their several charges upon such contact.

Happily, however, the introduction of about one gallon of water per minute in the form of a fine spray at the origin end of the duct will immediately reduce the voltage to zero.

Obviously, the 3000 volts here mentioned would indicate the possibility of a

[10] The Resinous Products & Chemical Co., Inc., Philadelphia, Pa. Mem. A.S.M.E.

[11] "Synthetic Substances With Rubber-Like Properties," by E. R. Bridgwater, MECHANICAL ENGINEERING, October, 1938, pp. 735–737.

[12] Thiokol Corporation, Trenton, N. J.

[13] "Control of Dust Explosions in Industrial Plants," by Hylton R. Brown, MECHANICAL ENGINEERING, December, 1938, pp. 936–938.

rather fat spark, which could be a source of ignition.

THEODORE WACHS.[14]

TO THE EDITOR:

The possibility of self-ignition of dust clouds by static sparks produced by the friction of the dust particles themselves as they are moved about by air currents, has been considered. Some experimental work has been done both in this country and in Europe. One report states that a gas ignition was obtained by the discharge from a wire screen through which dust was being blown, but to the best of my knowledge no actual dust ignitions have been obtained in these tests.

Research along this line is being continued because, as Mr. Wachs indicates, the measurement of static charges in dust clouds shows sufficiently high potentials to constitute a serious ignition hazard under certain conditions.

HYLTON R. BROWN.[15]

An Old Mill Wheel

TO THE EDITOR:

The photograph which you are using as a frontispiece in this issue is a picture of what remains of an old mill wheel, which is located in the town of Norfolk, Conn. Its history and construction are interesting.

The wheel was 21 ft in diameter, the gear teeth $2^1/_4$ in. circular pitch, 5 in. face. It is mounted on the shaft on six keys, which is presumably to facilitate in truing it.

Most people regard the multiple-spline shaft as a development of the automobile industry, and no doubt this is true, but here is evidence that our Connecticut mechanics of a hundred years ago also used the equivalent of the multiple-spline idea.

This wheel was built about 1835 by Augustus Roy and Augustus Smith, to furnish power for a tannery which according to history was a flourishing business until some time after 1856.

While there is no definite record, the castings were probably made in Lime Rock, Conn., from ore mined in Salisbury, Conn.

There are few subjects of more absorbing interest than the history of the early Connecticut mechanics.

H. R. BLAKESLEE.[16]

[14] Plant Engineer, R.C.A. Manufacturing Co., Inc., Camden, N. J.

[15] Senior Engineer, Chemical Engineering Research Division, U. S. Department of Agriculture, Washington, D. C.

[16] Thomaston, Conn.

A.S.M.E. BOILER CODE

Revisions and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PARS. P-102*b* AND U-68*b*. Add the following:

b If the percentage of elongation of any tension test specimen is less than that specified and any part of the fracture is more than $^3/_4$ in. from the center of the gage length of the 2-in. specimen, or is outside of the middle third of the gage length of the full-size specimen as indicated by the scribe scratches marked on the specimen before testing, a retest shall be allowed.

PAR. P-186*c*. Revise last sentence to read:

In vertical tubular and firebox type of boilers, the flanged-in bottom edges of the plates may be attached by fusion welding provided the CROWN SHEET IS SUSPENDED FROM THE UPPER TUBE SHEET OR WRAPPER SHEET BY TUBES, FLUES, OR STAYS, the load ON THE PLATES IN THE WATER-LEG due to the internal pressure is carried by stay-bolting and the inside width of the waterleg does not exceed 4 in. as shown in Fig. P-16; etc.

PAR. P-262. Revise to read:

P-262 Manhole [plates, cover plates] and handhole COVER plates AND YOKES, IF ANY, shall be of rolled, forged, or cast steel except that for pressures not exceeding 250 lb per sq in. and/or temperatures not exceeding 450 F, handhole COVER plates may be made of cast iron COMPLYING WITH SPECIFICATION S-13.

THE STRENGTH OF ALL SUCH PARTS TOGETHER WITH THE BOLTS AND YOKES, IF ANY, SHALL BE PROPORTIONED FOR THE SERVICE FOR WHICH THEY ARE USED.

PARS. P-299*j* AND U-20*f*. Revise to read:

Bronze fittings or valves may be made of material complying with either Specifications S-41 or S-46, provided the maximum allowable working stresses and temperatures do not exceed the values given in Table P-8 (U-4) [and shall be marked to indicate the class of material used]. SUCH FITTINGS OR VALVES SHALL BE MARKED TO INDICATE THE PRESSURE RATING. FITTINGS OR VALVES MADE OF MATERIAL COMPLYING WITH SPECIFICATION S-46 SHALL BE LIMITED TO USE WITH SATURATED STEAM. FITTINGS OR VALVES MADE OF MATERIAL COMPLYING WITH SPECIFICATION S-41, IF RECOMMENDED BY THE MANUFACTURER FOR TEMPERATURES ABOVE THAT OF SATURATED STEAM, SHALL ALSO BE MARKED WITH THE MAXIMUM TEMPERATURE RECOMMENDED.

PAR. P-329. Add the following:

When a boiler is completed or part of an incomplete boiler is ready for hydrostatic test, it shall be filled with water of a temperature not less than the temperature of the surrounding atmosphere and in no case less than 70 F or more than 150 F.

SPECIFICATION S-43. Reference to this specification to be included in Pars. U-71*a* and P-103*a*.

PAR. H-78. Add the following to the last sentence:

or where a cylindrical shell and a stayed wrapper sheet are joined by a lap weld.

PAR. U-55. Revise to read:

U-55 A manhole OR HANDHOLE reinforcing ring OR FRAME, when used, shall be of rolled, forged steel, cast steel, OR CAST IRON and shall comply with the requirements of Par. U-59*g*.

Par. U-58. Revise to read:

U-58 Manhole [plates] and HANDHOLE cover plates AND YOKES shall be of rolled, forged, or cast steel, CAST IRON, OR NONFERROUS MATERIAL.

[and their] THE STRENGTH OF ALL SUCH PARTS together with [that of] the bolts and [of the] yokes, if any, shall be proportioned for the service for which they are USED [intended].

Table P-2

Table P-2. The following is a proposed revision of Table P-2 to replace Table P-2A appearing in January, 1938, MECHANICAL ENGINEERING:

TABLE P-2 MAXIMUM ALLOWABLE WORKING PRESSURES FOR SEAMLESS STEEL, LAP-WELDED STEEL, LAP-WELDED WROUGHT-IRON AND ELECTRIC-RESISTANCE-WELDED STEEL TUBES OR NIPPLES FOR WATER-TUBE BOILERS FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS S-17, S-40, AND S-32*

SIZE OUTSIDE DIAMETER, INCHES		1/2	3/4	1	1-1/8	1-1/4	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4	3	3-1/2	3-1/2	3-3/4	4	4-1/2	5	
WALL THICKNESS, INCHES	NEAREST BWG NO.																			WALL THICKNESS, INCHES
0.055	17–	330	120																	0.055
0.065	16	780	390	220	160	120														0.065
0.075	15+	1150	670	430	350	280	190													0.075
0.085	14+	1570	950	640	530	450	330	240	170											0.085
0.095	13	1980	1220	840	720	620	460	360	270	210	160	120								0.095
0.105	12–		1500	1050	900	780	600	470	380	300	240	190	150							0.105
0.120	11		1910	1360	1180	1090	810	650	530	440	370	310	260	210	180	150				0.120
0.135	10+			1670	1450	1280	1020	850	690	580	490	420	360	310	270	230	200			0.135
0.150	9+			1980	1730	1530	1220	1010	840	720	620	530	460	410	360	310	270	210	160	0.150
0.165	8				2000	1770	1430	1180	1000	850	740	650	570	500	440	390	350	280	220	0.165
0.180	7					2020	1640	1360	1150	990	860	760	670	600	530	480	430	350	280	0.180
0.200	6–						1910	1600	1360	1180	1030	910	810	720	650	590	530	440	370	0.200
0.220	5							1830	1570	1360	1200	1060	950	850	770	700	640	530	450	0.220
0.240	4+							2070	1770	1540	1360	1210	1080	980	890	810	740	620	530	0.240
0.260	3+								1980	1730	1530	1360	1220	1110	1010	920	840	720	620	0.260
0.280	2–									1910	1690	1510	1360	1230	1120	1030	950	830	700	0.280
0.300	1									2100	1860	1660	1500	1360	1240	1140	1050	900	780	0.300
0.320											2020	1810	1640	1490	1360	1250	1150	990	860	0.320
0.340												1960	1770	1620	1480	1360	1260	1080	950	0.340
0.360													1910	1740	1600	1470	1360	1180	1030	0.360
0.380													2050	1870	1720	1580	1460	1270	1110	0.380
0.400														2000	1830	1690	1570	1360	1200	0.400
0.420															1950	1800	1670	1450	1280	0.420
0.440															2070	1910	1770	1540	1360	0.440
0.460																2020	1880	1640	1440	0.460
0.480																	1980	1730	1530	0.480
0.500																	2090	1820	1610	0.500

* NOTE: These values have been increased to the next higher unit of 10 where the actual values exceed an even unit of 10.

FORMULAS

Basic Formula [A] $$\frac{P}{S} = \frac{2.3\,(t - 0.04)}{D} - 0.03333$$

where P = maximum allowable working pressure, lb per sq in.,
S = maximum allowable stress, lb per sq in. (Table P-9),
t = thickness tube wall, in.,
D = outside diameter tube, in.

For seamless steel tubes (Specifications S-17 and S-40) $S = 9000$ lb corresponding to the values in the above table:

[B] $$P = \frac{20700\,(t - 0.04)}{D} - 300$$

Notes on Table P-2

1 For pressures higher than those given in the table the allowable working pressure shall be the next higher units of ten above the values given by the formula. No tube should be allowed a working pressure in excess of that permitted by formula [G], with the value of S taken from Table P-6 (to be reinserted and revised), for the material from which the tubes are made, at a temperature not less than the mean temperature of the tube. For this purpose the mean temperature is defined as the average temperature of the inside and outside tube surface which is expected to exist with the maximum designed heat absorption per square foot of tube surface.

2 For lap-welded wrought-iron tubes Table P-2 may be used for values above the first and uppermost horizontal stepped line. For values below this line the following formula shall apply:

[C] $$P = \frac{12190\,t}{D} - 177$$

corresponding to a value of $S = 5300$ in formula [G].

3 For lap-welded steel tubes Table P-2 may be used for values above the second horizontal stepped line. For values below this line the following formula shall apply:

[D] $$P = \frac{16100\,t}{D} - 233$$

corresponding to a value of $S = 7000$ in formula [G].

4 For electric-resistance-welded steel tubes Table P-2 may be used for values above the third and lowermost horizontal stepped line. For values below this line the following formula shall apply:

[E] $$P = \frac{17595\,t}{D} - 255$$

corresponding to a value of $S = 7650$ in formula [G].

5 For Grade C tubes, Specification S-49 (A.S.T.M. Spec. A210-38T) and carbon molybdenum tubes, grade T1a, Specification S-48 (A.S.T.M. Spec. A209-38T), the value of S in formula [A] may be 12,000 giving the following formula:

[F] $$P = \frac{27600\,(t - 0.04)}{D} - 400$$

6 The following formula may be used for determining the maximum allowable pressures for seamless steel tubes for forced-circulation water-tube boilers:

[G] $$\frac{P}{S} = \frac{2.3\,t}{D} - 0.03333$$

[H] For $S = 9000$ $$P = \frac{20700\,t}{D} - 300$$

[I] For $S = 12000$ $$P = \frac{27600\,t}{D} - 400$$

7 For use in the Unfired Pressure Vessel Code to apply to heat exchangers and other vessels using steel or wrought-iron tubes, formula [G] would apply with the proper value of S taken from Table U-3½ (to be inserted similar to Table P-6 revised). For welded tubes, formulas [C], [D], and [E] would apply.

8 The minimum thickness for tubes for water-tube boilers, or for unfired pressure vessels or heat exchangers, where the tubes are expanded into drums or headers, shall be as indicated in Table P-2, for the minimum pressure shown for each diameter.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Steam-Engine History

A Short History of the Steam Engine. By H. W. Dickinson. University Press, Cambridge; The Macmillan Company, New York; 1939. Cloth, 6⅛ × 9½ in., 256 pp., illus., $3.50.

TO AN imposing list of biographies and historical sketches relating to engineers and engineering, Henry Winram Dickinson, the distinguished former assistant to the director of the Science Museum, South Kensington, London, and honorary secretary of the Newcomen Society, has added "A Short History of the Steam Engine," which commences with a review of some of the antecedents of this useful and versatile prime mover and ends with mention of such modern plants as those in which Brown, Boveri incorporate the Velox boiler. For the subject of the steam engine as Dickinson treats it involves not only the reciprocating engine, part I, and the steam turbine, part II, but steam generators and auxiliary power-plant equipment as well. Naturally, with such a variety of apparatus and machinery, and with so long a period of years to cover, the history must indeed be a "short" one in order to accommodate itself to the space afforded by 250 pages. These factors, together with Dickinson's easy style, make reading possible and pleasant to a wide audience; and indeed the book should find a wide circle of readers, not only among engineers, but among educated laymen and particularly those whose interests or specialties bring them face to face with the powerful influences that have shaped and conditioned our industrial civilization.

On this last point the preface of the book says that the author "hopes to interest the general public, especially the younger generation, and in doing so he wishes he may be able to clear away some of the errors into which previous writers have fallen and which have been repeated time and again; in particular the author will feel that his labours have not been in vain if he succeeds in uprooting the fallacies that James Watt invented the steam engine, and George Stevenson the locomotive." Such labors indeed are not in vain, for Watt does not appear until chapter 5 on page 66. As to the development of the steam engine for locomotives and steamships the book is intentionally silent, because of much available information on the former subject and of the recent work of E. C. Smith dealing with the latter, a book reviewed in these pages last September

It would be easy to develop many lines of thought opened up by Dickinson's "short history," but to do so would go beyond the realm of a review. For example, how much there is to say regarding the frequently mentioned interrelationship of the steam engine, the machine tool, metallurgy, the progress of the mechanic arts, the function of business management, the patent system, and scientific and industrial research. The immediate antecedents of the steam engine and its original use in mechanisms for unwatering the drowned mines of Cornwall, the economic and social repercussions of steam power, the rôle played by patent monopolies and competition, all necessarily briefly treated, are suggestive of interesting possibilities of development, but, unfortunately or otherwise, the history is a short one and aims at a broad presentation, not exhaustive treatment. But we are grateful for the fact that these subjects are brought to our attention.

Although Dickinson has included some account of developments in the field of thermodynamics, one might wish that this subject had been introduced earlier in the work, even though in point of historical sequence what scientists discovered about heat and heat engines trailed by several generations the machine as made by practical engine builders. A more sharply delineated thermodynamic background against which to assess the products of inventors who possessed more mechanical ingenuity than scientific theory, by means of which the reader would be led to understand why some designs persisted while others failed or died out, would be useful. Mr. Dickinson does include a chapter on developments in heat-engine theory, and the reviewer's comments are, therefore, an expression of individual preference in arrangement. It was probably by design that the fascinating subject of rotary engines that has obsessed so many inventors receives scant notice, but one wonders why the binary-vapor engines, and particularly the mercury-vapor plant developed by W. L. R. Emmet, were not mentioned.

The illustrations, of which there are 78, with 11 plates, are excellently executed and extremely useful in comprehending the text. Special mention should be made of the chart tipped in to the back of the book which contains a synopsis of events in the history of the steam engine. The chart covers principally the period from 1600 to date and records in chronologically parallel columns the following data: Important events in pure and applied science whose influence on the development of prime movers was direct or indirect; span of life of inventors associated with the development of prime movers; natural power engines; heat engines other than steam; stationary steam engines; engine details; stationary boilers; boiler details; curves showing population of England and Wales; coal and pig iron produced, and miles of railway open, United Kingdom; and important economic and political events in English and world history—a useful chart that will repay much study.—G.A.S.

Engineering and Civilization

Engineering's Part in the Development of Civilization. By Dugald C. Jackson. The American Society of Mechanical Engineers, 1939. Cloth, 5¼ × 7¾ in., $1.55.

Reviewed by A. A. Potter[1]

IN THE July, 1938, issue of Mechanical Engineering there appeared the first of a series of six lectures, "Engineering's Part in the Development of Civilization," which were delivered by Prof. Dugald C. Jackson at Raleigh, N. C., Jan. 21 to 29, 1938. The editor of Mechanical Engineering in commenting editorially on this series of lectures stated: "Anyone who knows the author of these lectures, and few there are in engineering circles who do not, realizes that anything that the distinguished professor emeritus of electrical engineering at the Massachusetts Institute of Technology has to say on such a subject ought to be heard. With a life-

[1] Dean, Schools of Engineering, Purdue University, West Lafayette, Ind.

time of engineering practice and contact with young men as a background, Dr. Jackson has given expression to the results of years of reading and study of a subject too few engineers have troubled themselves to investigate."

As the series of Professor Jackson's lectures followed in the issues of MECHANICAL ENGINEERING from July to December, 1938, thoughtful readers gained a new spirit of reverence for the past of their profession, a renewed pride in the accomplishments of engineering, and a better appreciation that "true civilization is dependent on the fruits of engineering, but it cannot be brought to full embodiment any faster than the manifest intelligence of the people leads the procession toward it."

Starting with the conditions of living of the earliest men, Dr. Jackson shows how engineering knowledge has broadened and deepened from the dawn of history to our own times. The final chapter is concerned with the present relation and future outlook for civilization in an engineering world. In his concluding paragraph he states that, "civilization gained its birth out of facilities provided by a then newly conceived engineering; civilization has grown, and has become sweeter, as the ages have rolled on and engineering facilities have been extended; rashly applied efforts to overspeed improvements beyond the standards of thinking of the people ultimately defeat their own ends; and our alarm should be strongly stirred as we observe that ethical progress is retarded or even arrested in certain European nations by overdomineering political methods which are there being applied."

The American Society of Mechanical Engineers has performed a distinct service to the engineering profession by publishing these lectures in the form of a book, a valuable addition to the library of engineering history. This book, by acquainting the engineer with the past history of his calling, should prove an aid to him in the understanding of his profession, in making him more fully professionally minded, and in enabling him to appreciate more adequately present conditions.

Books Received in Library

A.S.T.M. SPECIFICATIONS FOR PIPE AND PIPING MATERIALS FOR HIGH-TEMPERATURE AND HIGH-PRESSURE SERVICES. American Society for Testing Materials, Philadelphia, 1938. Paper, 6 × 9 in., 128 pp., diagrams, tables, $1.25. This pamphlet is a compilation of various A.S.T.M. standard and tentative specifications for steel piping materials used in high-temperature and high-pressure services, covering pipe and tubing, castings, forgings, and bolting for several industrial installations.

ATM (Archiv für technisches Messen), Lieferungen 88–90, Oct.-Dec., 1938. R. Oldenbourg. Munich and Berlin. Paper, 8 × 12 in., illus., diagrams, charts, tables, 1.50 rm each. Three numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Certain numbers also contain descriptions of specific instruments manufactured by German companies.

AGENDAS DUNOD. BÉTON ARMÉ. By V. Forestier. Twelfth edition, 307 pp. CHIMIE, by E. Javet. Fifty-eighth edition, 383, pp. CONSTRUCTION MÉCANIQUE, by J. Izart. Fifty-eighth edition, 356 pp. ÉLECTRICITÉ, by L. D. Fourcault. Fifty-eighth edition, 383, pp. MÉTALLURGIE, by R. Cazaud. Fifty-fifth edition, 326 pp. MINES, by E. Stalinsky. Fifty-eighth edition, 279 pp. PHYSIQUE INDUSTRIELLE, by J. Izart. Nineteenth edition, 392 pp. Dunod, Paris, 1939. Leather, 4 × 6 in., illus., diagrams, charts, tables, 25 fr each. These convenient little handbooks provide information, formulas, and tables frequently wanted by workers in the various fields, at a remarkably low price. Each work is revised annually, new material being added as required.

BACKGROUND TO MODERN SCIENCE. Edited by J. Needham and W. Pagel. The Macmillan Co., New York; University Press, Cambridge, England; 1938. Cloth, 6 × 8 in., 243 pp., diagrams, $2. This volume contains ten lectures on the history of science at the University of Cambridge. The lectures deal chiefly with developments in various fields of science, such as physics, astronomy, physiology, and genetics, during the last forty years, and are the work of eminent professors at the University. Two introductory chapters treat of the beginnings of scientific thinking among the Greeks and of developments from Aristotle to Galileo.

BLAST FURNACE PRACTICE. By R. H. Sweetser. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 356 pp., illus., diagrams, charts, tables, $4. A comprehensive, practical manual on all aspects of the production of pig iron. It covers the blast-furnace plant, equipment, and raw materials, operating practice, character and utilization of products and by-products, theories of the process, commercial aspects, and obsolescence, with emphasis on the operating man's viewpoint. The book is the first American work on its subject to be published in many years, and will be welcomed by every furnaceman.

BOOK OF A.S.T.M. TENTATIVE STANDARDS, 1938. American Society for Testing Materials, Philadelphia, 1938. Cloth and paper, 6 × 9 in., 1758 pp., illus., diagrams, charts, tables, paper, $7; cloth, $8. This annual publication contains the tentative specifications, methods of testing, definitions of terms, and recommended practices covering materials of engineering and the allied testing field, proposed by the American Society for Testing Materials.

CAPITAL CONSUMPTION AND ADJUSTMENT. By S. Fabricant. National Bureau of Economic Research, New York, 1938. Cloth, 6 × 9 in., 271 pp., charts, tables, $2.75. This report is a study of the records of capital consumption and adjustment in the United States since 1918. The concept of capital consumption is developed, the nature of the available records considered, and the changes necessary to adapt them to a broader economic view are discussed. Capital adjustment data and their economic significance are then reviewed and their economic significance considered. An appendix applies the results to the interpretation of book values of capital assets and changes in these values.

CONTRIBUTIONS FROM THE PHYSICAL LABORATORIES OF HARVARD UNIVERSITY for the years 1936 and 1937, series 2, vols. 3 and 4. Harvard University Press, Cambridge, Mass., 1938–1939. Cloth, 8 × 11 in., illus., diagrams, charts, tables, $4 each volume. The papers that appear in these volumes have previously appeared in various scientific journals during 1936, 1937, and 1938. Collected, they represent the activities of the laboratories in many fields of study.

CONTRIBUTIONS TO THE MECHANICS OF SOLIDS DEDICATED TO STEPHEN TIMOSHENKO by his friends on the occasion of his sixtieth birthday anniversary. The Macmillan Co., New York, 1938. Cloth, 6 × 10 in., 277 pp., illus., diagrams, charts, tables, $5. In celebration of the sixtieth birthday of Professor Timoshenko, this collection of papers by various friends has been published. Twenty-eight contributions upon the mechanics of solids are included, dealing with a wide variety of problems. There is also a brief biographical sketch and a list of Timoshenko's published books and papers.

CONVEYING MACHINERY. By W. H. Atherton. The Technical Press, London, 1937. Cloth, 6 × 10 in., 188 pp., illus., diagrams, charts, tables, cloth, 21s. The descriptions of equipment, installations, and uses of package and bulk conveyers are in great part a record of the author's first-hand experience. A separate chapter discusses the relation of conveyers to a specific industry (foundries). An extensive table of densities of bulk materials and a short list of references are appended.

DESIGN OF INDUSTRIAL EXHAUST SYSTEMS. By J. L. Alden. Industrial Press, New York, 1939. Cloth, 6 × 9 in., 220 pp., diagrams, charts, tables, $3. "The purpose of this book is to tell the engineer how to design and build or how to buy an exhaust system that will adequately and economically perform the functions prescribed by the industrial-hygiene expert or by the law." The book discusses the flow of fluids, hood forms, piping design, dust separators, conveyers exhaust fans, planning of systems, etc.

ECONOMICS OF TRANSPORTATION. By D. P. Locklin. Revised edition. Business Publications, Inc., Chicago, 1938. Cloth, 6 × 9 in., 863 pp., diagrams, maps, tables, $4. This comprehensive volume emphasizes the problems of rate-making and regulation chiefly with respect to railroad practice, although the subjects of pipe line, water, highway, and air transportation are also considered critically. The effect of railroad development on the general economic system is discussed, the various ways in which undue discrimination is practiced are explained, and the provisions of the several regulatory Transportation Acts are described. The book ends with a chapter on transport coordination.

ROMANCE OF AMERICAN TRANSPORTATION. By F. M. Reck. Thomas Y. Crowell Co., New York, 1938. Cloth, 7 × 9 in., 253 pp., illus., $2.50. A readable popular history of the development of transportation from 1789 to the present, with well-chosen pictures.

A.S.M.E. News

And Notes on Other Engineering Activities

A.S.M.E. Spring Meeting in New Orleans on Feb. 23–25 Draws 800 Members and Guests

Joint Events With L.E.S. Include Inspection Trips, Some Technical Sessions, and Parties

NEARLY 800 members and guests attended the Spring Meeting of The American Society of Mechanical Engineers, held in colorful New Orleans at the St. Charles Hotel, February 23–25, and took part in a program which combined technical sessions and plant inspections with highly enjoyable social events. The Annual Meeting of the Louisiana Engineering Society was held at the same time and same place and parts of the program were arranged for joint participation.

Technical Sessions

Power and fuels held the center of the stage in the technical sessions, with by-product fuels and by-product power given special consideration. The program began with a session on boiler feedwater under the chairmanship of W. B. Gurney. Failure of horizontal tubes in 1400-lb boilers may be traced to a steam blanket forming at the top and causing overheating, according to a paper by R. E. Hall and E. P. Partridge. Examples of such failure, as presented in a series of case studies, were analyzed by the authors. Experimental verification of some phases of this paper was presented by F. G. Straub and E. E. Nelson, who reported on "Corrosion in Partially Dry Steam-Generating Tubes." Another aspect of boiler-water problems was discussed in "Mechanical Purification of Steam Within the Boiler Drum," by M. D. Baker. This paper described three designs of baffles intended to reduce carry-over, citing tests by the conductivity method which led to the adoption of the third type, cyclone separators in the drum.

At a simultaneous session, sponsored by the Management Division, and presided over by E. W. Burbank, E. W. O'Brien told a vitally interested group of "The Industrial Renaissance of the South." Choice of the word "renaissance" was dictated by the fact that the South had an early industrial history, based on its climate and resources, and so the present growth may be considered as a swinging back of the pendulum. (The complete paper will be found on pages 281–286 of this issue.) A vigorous discussion of special management problems faced by Southern industry brought this session to a close.

Waste Fuels Symposium

Waste fuels, important in many Southern industries, was the general topic of a six-paper symposium which, under the chairmanship of E. L. Dennis, covered the burning of such diverse fuels as oathulls, pulp-mill waste, oil-refinery by-products, wood waste, bagasse, and steel-mill by-products. Many of these are old arts with well-developed techniques, and

MEMBERS AND GUESTS OF THE LOUISIANA ENGINEERING SOCIETY AND THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS HOLD JOINT DINNER AT NEW ORLEANS MEETING

papers reviewed past work while presenting modern practice. At least one, the problem of recovering the waste from digesters in the sulphite process, was completely new and considerable interest attached to the presentation of a paper describing the recovery process and methods of burning the lignin fuel which results.

Two Unusual Fuels Described

In another session sponsored by the Fuels Division, at which F. G. Frost served as chairman, two relatively unusual fuels were studied. Prof. C. J. Eckhardt, Jr., summarized a research investigation on lignite, conducted by the University of Texas, which showed that this low-rank fuel can be burned to advantage in properly designed furnaces, and may be economically suitable in many parts of the Southwest. Hard pitch, a by-product of the distillation of oils from coal tar, is produced in excess of its commercial demand, according to a paper by E. W. Clarke, and is a fuel of excellent quality. It can be burned in pulverized form, in a burner mounted outside the furnace proper in such a manner as to prevent particles coming in contact with heated surfaces before burning in suspension. This eliminates plugging the burner with softened pitch, a problem with burners previously used.

By-Product Power Session

By-product power came into the picture in two papers discussing various phases of power stations designed to generate steam and power for associated industrial plants, and supplying surplus power to a utility system. Each paper referred to a specific application of this plan of joint generation; "Economics of a Power Plant for Joint Utility and Industrial Service," by A. C. Klein and T. E. Crossan presented certain features of operations at Louisiana Station, Gulf States Utilities Co., Baton Rouge, La., while "Power and Steam Plants for Oil-Refinery Service," by C. E. Steinbeck described design features of three plants built by the Pacific Gas & Electric Co. at three large oil refineries. A third paper, by H. R. Pearson, told of unique features of the semi-outdoor Mountain Creek Station, Dallas, Texas, which include an artificial lake for condensing, and a forced-ventilation system supplying conditioned air to all parts of the turbine room, boiler-firing aisle, and pump room.

Reducing Fire Loss

Dramatic reductions in fire losses on New Orleans wharves resulted from installation of automatic sprinklers in sheds and below wharf floors, and of draft stops, according to a paper by John McKay, general manager, Board of Commissioners of the Port of New Orleans, presented by F. L. Holt, fire-prevention engineer for the Board. This Safety session was sponsored by the New Orleans Committee and was presided over by John S. Huey.

Numerous special aspects of Southern industry were covered in sessions sponsored by the Petroleum Division and the Process Industries Division. In the former, under the chairmanship of Dr. W. E. Winship, results of an "Investigation of Oil-Well Surface Dynagraph Cards" were presented by S. B. Sargent, Jr., and R. W. Rieniets. Subsurface dynagraph cards obtained with the Gilbert-Sargent pump dynagraph were compared with corresponding surface cards. In "The Design of Control Equipment for High-Pressure Oil and Gas Wells," Herbert Allen discussed problems of equipment to control oil wells of high pressures, indicating general design trends.

Interesting Process Session

Cottonseed processing, pulp and paper making, and cane milling engrossed engineers attending the Process session Saturday morning. Reporting on investigations at the Tennessee Experiment Station, W. R. Woolrich told of tests on a pilot unit using pressure cooker and auxiliary mill equipment, which showed applicability of equipment to seed of all qualities and made possible increased yield and better control of production. Placing stress on developments peculiar to the industry in the South, A. W. Allison, Jr., described the methods and equipment used in the manufacture of pulp and paper, including the processes for recovery of chemicals from waste liquor. A. G. Keller, in "Factors in Cane Milling," told of an experimental sugar-cane milling plant at Louisiana State University and reported on improvements in design which resulted in increase in capacity without loss of efficiency.

Inspection Trips

Plant trips were jointly participated in by members of A.S.M.E. and the Louisiana Engineering Society. On Thursday, attending engineers had a choice of two trips, one on a yacht furnished by the Board of Commissioners of the Port of New Orleans, and the other on a special car drawn by a Diesel-electric locomotive, furnished by the Public Belt Railroad. Those taking the boat trip saw more than $200,000,000 of port and harbor improvements, including an extensive longitudinal wharf system on the east bank of the river, the cotton-warehousing facilities, the public grain elevator, the levees, and the Huey P. Long Bridge. This bridge was crossed by the group taking the railroad trip; other high spots included an inspection of the modern roundhouse of the Public Belt Railroad.

Friday afternoon's trip started early enough for lunch at the Norco refinery of the Shell Petroleum Corp.; after traversing the vast expanse of the refinery, the group moved on to the Bonnet Carre spillway, which diverts flood waters from the Mississippi to Lake Ponchartrain and the Gulf of Mexico. Next on the schedule was the Godchaux Sugar Refinery at Reserve, La., and on the return trip the group saw the Huey P. Long Bridge.

Joint Sessions

Two special features of the program were the Engineering Education Luncheon and the Ordnance Meeting. The former was held Thursday noon, under the joint auspices of the Society for the Promotion of Engineering Education and the A.S.M.E. Prof. James M. Robert, Dean of Engineering at Tulane, presided, and speakers included Dr. D. S. Elliott, Tulane University, Dr. L. J. Lassalle, Louisiana State University, and Prof. A. G. Christie, President of the A.S.M.E.

According to custom, a public meeting is part of the program of every Louisiana Engineering Society Annual Meeting. Speaker for this year's forum, held Friday evening, was Major-General C. M. Wesson, Chief of Ordnance, U. S. A., whose talk "America Looks to Her Guns" surveyed the problems of national defense with special reference to the ordnance needs of the army, and to the part played by the engineer in this field. (The paper is published in full in this issue, starting on page 273.) D. W. Godat, President of the L.E.S., presided and the speaker was introduced by A. G. Christie, President of the A.S.M.E.

Southern Hospitality

A "Plantation Party" at the Southern Yacht Club on the shores of Lake Pontchartrain, started the social ball rolling Thursday night. With many local members of the A.S.M.E. and L.E.S. in costumes ranging from blue-denim farm outfits to eighteenth-century court dress, the affair was colorful and informal. Dancing was interrupted later in the evening for a floor show which was heartily enjoyed, to judge by the applause.

Final event of the meeting was the banquet and dance, held Saturday night at the St. Charles Hotel, convention headquarters. Dr. Rufus C. Harris, President of Tulane University, acting as toastmaster, introduced the presidents of the participating societies, Messrs. Godat and Christie, each of whom made a few remarks. After presentation of L.E.S. life memberships, scholarships, honorary memberships, and a gift to the retiring president, B. H. Grehan, coffee was served in the Hunt Room and dancing concluded the evening and the meeting.

The woman's auxiliary to the Louisiana Engineering Society entertained the wives of visiting members of the A.S.M.E. and L.E.S. The first event was a tea at "Bel-Air," residence of Mr. and Mrs. William Von Phul, on Thursday afternoon, followed by a lecture on New Orleans by Mrs. Henry F. Reynick and the rendition of negro spirituals by a group of talented singers. On Friday, a typical Southern luncheon was enjoyed at the famous Orleans Club. A late breakfast was held at the Little Shop Around the Corner on Saturday morning, followed by a tour of the picturesque Vieux Carre, the French quarter of New Orleans. Of course, all the women participated in the plantation party, the ordnance meeting, and the banquet and dance.

Committees

Credit for the fine program of technical sessions, inspection trips, and social events for the A.S.M.E. Spring Meeting of 1939 is due to the many committee members whose untiring efforts made it possible. Chairman of the general committee was James M. Todd, past vice-president of the Society. Others on this committee were L. J. Cucullu, secretary; C. A. Bender, Jr., publicity; C. C. Crawford, hotel; T. R. Flower, printing and signs; F. G. Frost, local finance; G. R. Hammett, information and registration; K. P. Kammer, entertainment; R. H. Knipping; E. A. McLellan, Junior Group participation; R. F. Muller, transportation; B. S. Nelson, technical events; D. W. Stewart, plant trips; and W. E. Winship, reception. Members of subcommittees

included L. J. Lassalle, J. K. Mayer, C. H. Durning, H. F. Coleman, Charles Wiggin, Jr., E. L. Dennis, J. S. Huey, A. D. Stancliff, D. B. Benscoter, C. I. Crais, A. C. Davis, Walter Holloway, Hugh Luehrmann, P. G. Merritt, Jr., M. P. Michel, H. F. Reynick, P. F. Hoots, J. Walker Ross, A. M. Lockett, R. T. Burwell, D. Jahncke, R. P. Lockett, J. K. Mayer, J. M. Robert, R. G. Webb, William Whipple, A. B. Paterson, T. H. Roberts, and J. R. Rombach.

Women's committees included entertainment, Mrs. D. W. Godat, chairman; Mrs. F. H. Fox, vice-chairman; Mrs. Wade Barnett, Mrs. A. M. Fromherz; Mrs. H. F. Reynick; Mrs. J. M. Robert; and Mrs. W. H. Scales; reception, Mrs. D. S. Elliott, chairman; Mrs. D. S. Anderson; Mrs. D. W. Godat; Mrs. W. B. Gregory; Mrs. B. H. Grehan; Mrs. K. P. Kammer; Mrs. J. M. Robert; and Mrs. J. M. Todd; and registration, Mrs. G. R. Hammett, chairman; Mrs. F. N. Billingsley; Miss Angela Gregory; Mrs. B. S. Nelson; and Mrs. C. S. Williamson.

Birmingham Members and Manufacturers Outdo Themselves in Entertaining A.S.M.E. Tour Party

All-Day Affair Includes Visits to Four Cast-Iron-Pipe Plants, Luncheon, Tour of City, and Banquet

BIRMINGHAM was the scene of one of the finest receptions ever accorded to a visiting party of engineers and their ladies when, on Feb. 20, the members of the Birmingham Section and four cast-iron-pipe manufacturers entertained 50 engineers and their ladies from New York and other cities who stopped off for one day on their way to the Spring Meeting of the Society in New Orleans, La., Feb. 23–25. The program developed for the men, as well as that for the women, was as complete and in as great detail as that of a national meeting of the A.S.M.E. The well-planned schedule was kept almost to the minute and, although four large pipe-manufacturing plants were visited and a tour of the city made, the party did not become fatigued at all. The entertainment for the women was superb and so hospitable that all regretted their inability to stay longer.

Inspection Trips to Plants

With the arrival of the train from New York, the men boarded a special chartered bus and were taken on a tour of four cast-iron-pipe companies. The first stop was made at the foundry of the McWane Cast Iron Pipe Company where the visitors saw the process of making six 4-in. pipes, each 16 ft long, in a flask or container, at one time. These flasks were rammed on large pneumatic machines while the core bars made of green sand were formed on a revolving spindle in less than half a minute. Flasks, core bars, and other equipment are used over and over again many times during each working shift. There was also shown the manufacture of six 2-in. pipes, 9 ft long, in one flask; the finished pipes were equipped with oversize male and female threaded joints, assembled, and shipped in 18-ft lengths. The company is the world's largest producer of small-diameter cast-iron pipe. It also makes several types of pipe joints, all sizes and types of fittings, and special castings.

The next plant visited was that of the National Cast Iron Pipe Division of James B. Clow & Sons where the visiting engineers saw the manufacture of cast-iron pipe by the de Lavaud centrifugal process and the finishing and coating of the pipe, including the application of cement lining. Other methods of manufacture witnessed at this plant were the pit casting of pipe, the casting of fittings in the specials foundry, and the manufacture of small-diameter pipe by a horizontal casting method. The manufacture of fittings in this plant is done in several ways. Other processes of interest to the visitors were the finishing of sand-cast flange pipe and a new method of screwing flanges on de Lavaud centrifugal pipe. The reboring and refinishing of the steel molds used in the manufacture of de Lavaud pipe was viewed in the modern machine shop. Impressive to all was the fact that on the day of the visit, this plant had completed 576 days of operation without a lost-time accident. This is phenomenal in a plant that has a daily capacity of approximately 500 tons of cast-iron products and between 250 and 275 employees.

The third plant visited was that of the American Cast Iron Pipe Co., where the visitors were shown the company's medical clinic building with its staff of three doctors, five trained nurses, two dentists, an X-ray technician, and a laboratory assistant. The company furnishes medical service to all employees and their dependents. Next the party visited the experimental testing department with its new chemical laboratory and physical testing laboratory where the quality and standards of raw materials and finished products are constantly checked. From here the visiting engineers went to the No. 1 monocast pipe shop to witness the manufacture of cast-iron pipe in sand-lined refractory molds. The molten metal was poured from the cupolas into a mixing ladle, and from that into smaller bull ladles. At the casting machines, small casting ladles poured the molten iron into slowly revolving molds that accelerated to high speed, forcing and holding the metal against the sand-lined mold by centrifugal force until solidified. The cooled pipe was stripped out, cleaned, and tested with hydrostatic pressure to 500 psi. Pipes in sizes 3-in. to 12-in. diameter, 16 ft long, are made in this shop. At the No. 2 monocast pipe shop which was visited next the casting of larger pipes was seen; here monocast pipes in diameters from 14 in. to 36 in., 16 ft long are manufactured.

Following lunch, the fourth and last plant visited was that of the United States Pipe and Foundry Company. Much to its surprise and delight, the visiting party was greeted with a large sign on the lawn which read, "Welcome A.S.M.E." The visitors went through the forge and steel-working shops into the main machine shop where they saw several large castings, slightly over 10 ft in diameter and about 13 tons each, being machined before being sent out to the Grand Coulee Dam. Also seen were the machining of flexible-joint pipe as well as work on various miscellaneous smaller castings. The party then passed into the special foundry where the visit was timed so that one of the Grand Coulee Dam castings was being poured at the moment; then through the pattern shop, the iron yard, past the laboratories, and on into the main pipe foundry. Here the principal point of interest was the super de Lavaud units in full operation making pipes from 3 in. to 24 in. in diameter and in 12-ft and 18-ft lengths. A great deal of interest was also shown in the heat-treating process. After visiting the cement-lining department and seeing the comprehensive stock of pipe and fittings maintained at this plant, the group returned to the bus and were driven back to Birmingham for a tour of the city.

Ladies Program

Following a visit to the shopping district in the morning, the ladies were driven to the Birmingham Country Club for luncheon. After an afternoon of cards, golf, and sight seeing, the party attended a tea at the home of Mrs. O. G. Thurlow.

Banquet

The banquet in the evening at the Tutwiler Hotel featured an old-fashioned Southern-style chicken dinner. J. E. Getzen, chairman of the Birmingham Section, presided while Prof. John M. Gallalee, University of Alabama, acted as toastmaster and introduced S. D. Moxley, chairman of the arrangement committee and his fellow workers. After viewing a sound motion picture on "Pipe and the Public Welfare," the 68 members and 79 guests and ladies were treated to songs by the Pipe Shop Double Quartette and to "tinny" music by the Rub Bode Fo'. Much as they were reluctant to leave, the visiting engineers and their ladies finally had to say goodbye and continue their train journey to New Orleans.

Committee Members

Thanks cannot be expressed fully in printed words for the efforts expended by the following to make the one-day stay of the visitors both enjoyable and instructive: S. D. Moxley, chairman, George Bentley, W. P. Cox, J. W. Eshelman, J. E. Getzen, John Greagan, J. W. Moore, W. Joe Moore, secretary, H. G. Mouat, J. W. Orcutt, G. R. Ozley, Warren Whitney, L. W. Williams, treasurer, and Paul Wright. Finally, a word of extra-special thanks to the following ladies of Birmingham: Mrs. L. N. Shannon, chairman, Mrs. J. M. Barry, Mrs. W. P. Cox, Mrs. C. B. Davis, Mrs. J. W. Eshelman, Mrs. M. H. Geisking, Mrs. J. E. Getzen, Mrs. John Greagan, Mrs. G. H. Middlemiss, Mrs. H. G. Mouat, Mrs. S. D. Moxley, Mrs. R. L. Ogden, Mrs. J. W. Orcutt, Mrs. G. R. Ozley, Mrs. O. G. Thurlow, and Mrs. L. W. Williams.

San Francisco to Be Scene of A.S.M.E. Semi-Annual Meeting, July 10–15

City Offers Many Attractions to Visitors Beside 1939 World's Fair of the West

SAN FRANCISCO, the city on the Golden Gate, with its 1939 World's Fair of the West, is attracting hundreds of thousands of visitors from all parts of the world. Two of the outstanding events to be held there this summer will be the Semi-Annual Meeting of The American Society of Mechanical Engineers and the Regional Meeting of the American Institute of Mining and Metallurgical Engineers, July 10–15. Hundreds of rooms have been reserved at the Palace Hotel, headquarters for the two meetings, for the members and guests of the two engineering bodies.

Beside visits to Treasure Island to view the World's Fair, officially called the Golden Gate International Exposition; the celebration of Engineers' Day there on Thursday, July 13; the technical sessions of the A.S.M.E. on aeronautics, fuels, heat transfer, hydraulic equipment, applied hydraulics, management, oil and gas power, boiler plants, mechanical separation, and agricultural engineering; there will be many opportunities for those in attendance to see the sights of the cities of San Francisco and Oakland with their attractions and to make inspection trips to the industrial plants which are located in the area.

Interesting San Francisco

The handsome War Memorial building in San Francisco houses a museum, as well as the city opera and symphony. Market Street is the chief thoroughfare and the location of the main shopping center. Other places of general interest are the Civic Center, the famous Chinatown, the Latin and artists' quarters, Golden Gate Park which includes the Steinhart Aquarium and the Museum of the Academy of Sciences, the Zoo, Fishermen's Wharf, quaint restaurants, bathing beaches fronting on the beautiful Pacific Ocean, Lincoln Park, Dolores Mission (built in 1776), Cliff House, and the Presidio, an army post. A drive winding up Twin Peaks gives a splendid view of the city and of Oakland, Alameda, Berkeley, and other suburban cities across San Francisco Bay, as well as Treasure Island, site of the World's Fair. For the lovers of nature, Marin County, just across the Golden Gate Bridge, offers gardens, redwood forests, and stately mountains.

Plant Visits

It is too early to give a comprehensive list of the many plants and industries which will be visited during the Semi-Annual Meeting. It is sufficient to say at the present that the San Francisco and Oakland area is noted for its diversified industries, chief of which are meat packing, sugar refining, grinding of coffee and spices, making of machine-shop tools, and printing and publishing. Also of interest are the terminal for the transpacific airlines, the shops of the several railroads, the ships which dock in San Francisco, and the giant water and power projects. No member of the Society can afford to pass up this opportunity of a lifetime to visit the World's Fair of the West and to attend a National meeting of the A.S.M.E.

Californians, Inc.

THE FAMOUS FISHERMEN'S WHARF AT SAN FRANCISCO

C. E. Davies Will Represent I.M.E. at Automotive Congress

C. E. DAVIES, Secretary of the A.S.M.E., has accepted an invitation of The Institution of Mechanical Engineers (Great Britain) to act as its representative on the occasion of the 1939 World Automotive Engineering Congress, which is under the sponsorship of the S.A.E. The Congress will take place in New York, Indianapolis, Detroit, and San Francisco, May 22–June 8.

The 16-day program of the Congress opens in New York, May 22–28, with five days of technical sessions. Two additional days will be spent in visiting the World's Fair and other points of interest in and about the city. From New York the delegates will proceed to Indianapolis where they will view the Indianapolis Memorial Day race on May 30, after having inspected the racing cars and pits the previous day. The Congress will then travel to Detroit for three days (May 31–June 2) of inspection trips to automobile factories and a technical session. At San Francisco (June 6–8) the Congress will hold technical sessions and make visits to San Francisco's Golden Gate World's Fair. Members of the A.S.M.E. are invited to take part in the Congress.

A.S.M.E. Cosponsor for National Industrial Preparedness Dinner

TO HELP every American citizen and, particularly, the leaders of American industry familiarize themselves with the problems of national defense, a joint committee of representatives of professional and military societies has been organized for the purpose of holding a National Industrial Preparedness Dinner in the main ballroom of the Waldorf-Astoria Hotel, New York City, April 5, 1939. The Honorable Louis Johnson, assistant secretary of War, will make the principal address.

The American Society of Mechanical Engineers, one of the participating bodies, is represented on the joint committee by William C. Dickerman, president of the American Locomotive Company. The subscription for the dinner is $7.50. Reservations may be made by members of the Society through C. E. Davies, Secretary of the A.S.M.E.

A.S.M.E. Cooperates in N.Y. Safety Meeting

UNDER the auspices of the Greater New York Safety Council, of which the A.S.M.E. is a cooperating agency, the tenth annual convention will be held at the Hotel Pennsylvania, New York City, March 27–29. Among the 44 sessions listed are some of interest to mechanical engineers, namely, elevators, pressure vessels, materials handling, aeronautics, and petroleum. More information may be secured from Ernest Hartford, A.S.M.E. headquarters.

A.S.M.E. Metropolitan Section to Honor President Christie at One-Day Meeting

"Spring Round-Up" Features Ten Technical Sessions, Cocktails, Dinner, and Sociability

METROPOLITAN SECTION of the A.S.M.E. has undertaken the difficult task of trying to outdo all the other Local Sections of the Society in its welcome to President A. G. Christie. Consequently, the program committee of the Section, Charles A. Hescheles, chairman, has broken all precedents by scheduling one meeting for the month of April, instead of the dozen or two held each month by the various groups. The "Spring Round-Up," as it is called, has been set for April 20 at the Hotel Astor.

Starting at 2 p.m. and lasting until 6 p.m., the technical sessions, each about 15–20 minutes in length, will follow each other. The topics and speakers are as follows:

Aeronautics and National Defense, I. Sikorsky, chief engineer, Sikorsky Aircraft Co.

Fuels and Power, E. G. Bailey, vice-president, The Babcock & Wilcox Co.

Hydraulics, A. T. Larned, engineer, Phoenix Utility Co.

Machine-Shop Practice, John Haydock, editor, *American Machinist*.

Management, R. M. Gates, vice-president, Combustion Engineering Co.

Petroleum, Burton L. Boye, engineer, Socony-Vacuum Oil Co.

Photographic, Motion picture on "Pulp to Paper."

Railroad, L. K. Sillcox, vice-president, New York Air Brake Co.

Sanitation, Lieut.-Col. Oliver F. Allen, U. S. Army Reserve.

Transportation, Merrill C. Horine, engineer, Mack-International Motor Co.

To give the thousand or more members and guests who will attend an opportunity to get together, renew old friendships, and make new ones, a cocktail hour will be held from 6 to 7 p.m. Then at 7 p.m., dinner will be served, consisting of roast turkey with all the trimmings. Following this sumptuous feast, J. Schuyler Casey, president, M. H. Treadwell Co., and the toastmaster for the evening, will introduce the guest of honor, Prof. A. G. Christie, President of the Society, who will discuss "An Engineering Way Out." After giving members an opportunity to ask questions and discuss Professor Christie's paper, entertainment will be furnished until the wee hours of the morning by the National Broadcasting Company. One of the features will be Joseph Dunninger, master of mystery and magic.

Prof. Frank D. Carvin is chairman of the committee on technical sessions. His associates on the committee are V. M. Zaffarana, H. R. Kessler, E. J. Wiseman, R. F. Warner, W. S. Gleeson, A. F. Ernst, W. S. Patterson, P. E. Frank, H. A. Cox, A. J. Granata, William Raisch, H. R. Carlson, C. G. Humphreys, Adolf Ehbrecht, M. S. Symon, and G. J. Nicastro. William H. Larkin is chairman of the Dinner Committee which consists of the following subcommittees and their members: Contact Subcommittee, W. M. McKee, industries, Samuel Libby, old timers, Vincent Frost, past officers, T. Baumeister, Jr., colleges, and William Raisch, civil service; Entertainment Subcommittee, E. J. Billings, chairman, A. R. Mumford, and T. B. Allardice; Publicity Subcommittee, H. R. Carlson; and Tickets Subcommittee, C. K. Holland.

Further information about the affair will be found on page 24 of the advertising section.

News of Local Sections

Industrial-Waste Correction at Anthracite-Lehigh Valley

THE Reading meeting of the Anthracite-Lehigh Valley Section on Feb. 24, was a great success if the attendance of 65 members and 35 guests is any criterion. The guest speaker was Sheppard T. Powell, consulting chemical engineer of Baltimore, Md., who summarized the study and findings of the report on "Industrial Wastes," which was completed recently and presented to the Federal Government by the National Resources Board. With the aid of slides, Mr. Powell showed the amount of industrial waste and stream pollution in various parts of the country together with an analysis of the classes of industries that are responsible for such wastes. He showed how much of these wastes can be eliminated.

Atlanta Section Welcomes Secretary C. E. Davies

The Atlanta Section of the A.S.M.E. heard C. E. Davies on Mar. 3 at the Atlanta Athletic Club discuss "Building a Profession." Introduced by T. E. Bell, chairman of the Section, Mr. Davies described the program of the Engineers' Council for Professional Development and outlined the responsibility of the individual engineer in this program. About 40 members were present to welcome the Secretary of the Society.

Baltimore Has 325 at Diesel-Engine Session

Meeting jointly with the Baltimore Engineers Club and the local chapter of the S.A.E., the A.S.M.E. Baltimore Section presented a talk on "The General Motors Two-Cycle Diesel Engine," by W. A. Maynard, on Mar. 3. More than 325 attended, heard the talk, and inspected a display consisting of a Diesel-engined truck, a Diesel-driven generator, and a Diesel-powered bus of the Baltimore Transit Co. At a meeting on Feb. 8, members of the Section voted against the principle of registration of engineers and decided to oppose any bill which might be introduced in the legislature for this purpose.

200 at Metal-Cutting Meeting in Bridgeport

W. H. Sniffen, secretary of the Bridgeport Section, reports that the meeting on Feb. 14, attended by more than 200 members and guests, featured a talk on metal cutting by Malcolm F. Judkins, member A.S.M.E., and engineer, Firth-Sterling Co., McKeesport, Pa. In Mr. Sniffen's own words, "Mr. Judkins handled his subject excellently . . . outstanding in ability as a speaker . . . never before such keen interest."

Central Pennsylvania Has Meeting at State College

Following a dinner at the University Club, State College, Pa., on Feb. 23, 100 members and guests of the Central Pennsylvania Section listened to a talk on "Industrial Organization in Time of War," by Major S. B. Ritchie. He explained how the U. S. Army Ordnance Department hopes to secure rapid and effective cooperation of industries in case of war. Following his talk, sound movies of navy maneuvers were shown.

Maxwell C. Maxwell Talks Before Charlotte Section

Maxwell C. Maxwell, Yale and Towne Mfg. Co., was speaker at a meeting of the Charlotte Section on Feb. 2. He presented a film showing various industrial plants in the country and spoke briefly on the development of equipment used in these concerns. Approximately 60 members heard the talk.

Cleveland Section Views Coast Guard Movies

"The Coast Guard in Action" was the theme of the meeting on Feb. 6, sponsored jointly by the Cleveland Section and the Cleveland Engineering Society. More than 325 members and guests, assembled in the Guild Hall, were entertained by the feature of the evening, two 45-minute reels of sound motion pictures showing various phases of Coast Guard activities. Capt. George W. Cairnes, chief engineering officer of the Cleveland division of the U. S. Coast Guard, introduced the films with a short account of the origin, history, and duties of that branch of the government.

Detroit Section Has Joint Meeting With Canadians

The fourth meeting of the Detroit Section's current season on Feb. 28, featured the participation of the Border Cities Branch of the Engineering Institute of Canada. Starting at 2 p.m., members and their ladies visited the drug manufacturing plant of Parke, Davis & Co. At 6:30 p.m. 116 members and ladies sat down to dinner at the Intercollegiate Alumni Club. Following dinner, the session was called to order by Max W. Benjamin, chairman of the Section, who welcomed the E.I.C. Branch by greeting Boyd Candlish, chairman of the

Branch. Then Harvey N. Merker, manufacturing superintendent, Parke, Davis & Co., described the research, the manufacture, and the use of vitamins, drugs, and hormones.

In order to take care of the "out-state" member, who, although assigned to the Detroit Section, cannot participate in its activities, the officers of the Section have scheduled for April 28 a meeting in the City of Midland, some 125 miles north of Detroit, with the program based on the Dow Chemical Company's activities. Following an inspection tour of the plant, starting at 3 p.m., dinner will be served in the Dow cafeteria. At 8 p.m., Donald Gibb, research engineer of the company, will give a talk on "Modern Plastic Developments."

President A. G. Christie Speaks at Louisville

President A. G. Christie of the A.S.M.E. delivered an address before the Louisville Section on the evening of Feb. 28 in the lecture room of the Speed Scientific School. His subject was "Modern Steam Generators." L. L. Amidon, secretary of the Section, reports that the 55 members and guests enjoyed the meeting very much.

Members of Memphis Section Visit Firestone Tire Plant

Members of the Memphis Section spent more than three hours on Feb. 8 inspecting methods of tire and tube manufacture in the Firestone Rubber Company's local plant.

New Haven Presents Editor and Rocket Engineer

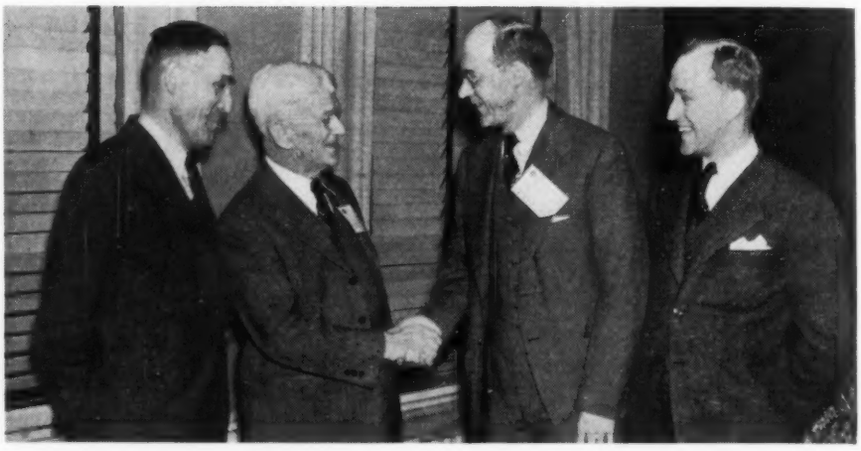
At a joint meeting of the New Haven Section and the Yale Student Branch on Feb. 15, about 50 students and members heard George A. Stetson, editor of the A.S.M.E. publications, including MECHANICAL ENGINEERING, give an enlightening talk on the selection and editing of papers for the several Society publications. He was preceded by R. F. Good, who presented a paper on rockets in which he presented their history, theory of operation, limitations, and future uses.

Double-Feature Program at North Texas Section

The Feb. 20 meeting of the North Texas Section in the Dallas Power & Light Company's auditorium saw the presentation of a double-feature program. First, there was an illustrated lecture on "Construction, Use, and History of Roman Structures in Southern France," by Prof. R. D. Landon of Southern Methodist University. The second feature was that baffling magician, Bill Salisbury the great, of the American Arch Co., who entertained with feats of magic that have never been performed before.

Ontario Section Hears Talk by L. W. Wallace on Research

About 50 members and guests of Ontario Section were present on Feb. 9 to hear Vice-President L. W. Wallace talk on research which he classified into three types, namely, fundamental, creative, and consumer. He illustrated each type with examples drawn from his extensive experience and pointed out the necessity of research to industry and its practicality in the average business of today.



AT ANNUAL PRESIDENT'S NIGHT OF ROCK RIVER VALLEY SECTION WHEN FELLOWSHIP INSIGNIA WAS GIVEN TO ELMER E. WOODWARD BY PRESIDENT CHRISTIE

(From left to right: Prof. B. G. Elliott of the University of Wisconsin; Elmer E. Woodward, president of the Woodward Governor Co.; Prof. A. G. Christie, President, of the A.S.M.E.; and R. C. Glazebrook, chairman of the A.S.M.E. Rock River Valley Section.)

Ordnance Officer Invited to Speak to Peninsula Section

The Commanding Officer of Rock Island Arsenal was requested by the Peninsula Section to designate an ordnance officer to give a talk before the Section late in March on "The Production of Cylinders of High Quality Finish." At a previous meeting, Lieutenant Houtman, of the Ordnance Reserve Corps, described the new Garand semiautomatic rifle. (See MECHANICAL ENGINEERING, March, 1939, page 235.)

Philadelphia Student Night Has an Attendance of 132

Meeting at the Engineers Club, 132 students and members of the A.S.M.E. attended Student Night of the Philadelphia Section. Speaker of the evening was G. Guy Via, supervisor of training, Newport News Shipbuilding & Dry Dock Co., who told of his many experiences in the personnel field and passed along an abundance of good advice to those present. At the dinner preceding the meeting, Major Thomas Coulson, British Intelligence Service, told of his adventures.

Pittsburgh Section Presents Paper on Coal Burning

Speaker at the Feb. 10 meeting of the Pittsburgh Section was C. A. Reed, director, bureau of engineering, National Coal Association. His paper dealt with the development of coal burning equipment for industrial and domestic use.

Plastics Is Subject of Providence Meeting

More than 140 members and guests were present at the Feb. 2 meeting of the Providence Section to hear a paper on "Plastics" presented by H. M. Richardson, General Electric Co. After describing the different kinds of plastics, Mr. Richardson showed a sound film, entitled, "Modern Plastics Preferred."

Rock River Valley Section Hears L. W. Wallace

Vice-President L. W. Wallace received an enthusiastic ovation upon the completion of his talk on "Research" before the Rock River Valley Section on Feb. 16. The talk was very comprehensive and offered much of an educational nature.

130 at St. Louis Meeting

At a joint meeting on Feb. 9 of the St. Louis Section and the St. Louis Engineers Club, 30 members and 100 guests heard a paper on "Pressure Vessels—Improvements in their Construction," by T. McLean Jasper, research engineer, A. O. Smith Corp. Of particular interest was the part played by the A.S.M.E. in developing codes for the manufacture and inspection of pressure vessels.

Plastics at San Francisco

On Feb. 23, L. L. Gribble gave a brief but comprehensive description of plastic materials, including use and suitability for various purposes. Erich Marx discussed molding processes and machines with particular emphasis upon injection-type molding. Both talks were illustrated with motion pictures and a large display of objects made from plastics. Prof. H. B. Langille, secretary of the Section, reports that the attendance exceeded 130.

Toledo Inspection Trip

Members of the Toledo Section of the A.S.M.E. and the local chapter of the S.A.E. were guests of the Spicer Mfg. Co. on Feb. 16 on an inspection trip through its plant. One of the most interesting things seen was a demonstration of a new hydraulic transmission.

Tri-Cities Hears About Machine-Tool Developments

More than 100 members and guests attended the Jan. 17 meeting of the Tri-Cities Section at the Rock Island Arsenal Auditorium to hear C. L. McMullen, vice-president, Gisholt Machine Co., tell of the latest developments in machine tools.

Safety Drive by Virginia Section Gives Results

At a meeting of the Virginia Section in Richmond on Nov. 18, 1938, members passed a resolution asking for legislation on boiler, elevator, and fire-escape codes for the State of Virginia. On Jan. 27, an engineering committee, consisting of T. A. Murphy, George L. Bascome, chairman of the Virginia Section, R. H. Barker, A. C. Norris, J. F. Lupton, E. H. Ruehl, E. B. Boynton, Thomas J. Starke, and E. S. Fitz, met with State Labor Commissioner Thomas B. Morton to compile information and recommendations and to form three committees, namely, boilers, elevators, and fire escapes.

Welding in Ordnance Work Before Worcester Section

Following a dinner on Feb. 16, members and guests of Worcester Section heard a paper on "Welding in Ordnance Construction," by W. L. Warner, welding engineer, Watertown Arsenal. There was also a 20-minute motion picture on automatic welding of railroad cars.

150 at Waterbury Section

More than 150 members and guests heard P. V. Faragher, of Pittsburgh, prominent metallurgist, describe the history and development of aluminum at a meeting of the Waterbury Section on Feb. 15. New Britain and Hartford Section members were guests. Motion pictures were used by Mr. Faragher to give his audience a close-up view of the mining of metals, development of alloys, fabrication processes used, and structural applications used in the production and application of aluminum.

Ladies' Night at Western Washington Draws 75

Ladies and wives of members of the Western Washington Section were invited to attend a dinner and meeting of the Section on Feb. 23. Dan Hage, junior A.S.M.E., and engineer, Boeing Airplane Co., gave a paper on the new type of automobile transmissions. Boaz Freeman, junior A.S.M.E., and engineer, U. S. Navy Yard, talked on powder metallurgy. Hosts for the occasion were Harold Adams, John Myroie, Charles Yost, and William Field. Hostesses were Mrs. Harold Adams and Mrs. Charles Yost.

Milwaukee and Rock River Valley Sponsor Conference

ONE of the biggest technical functions in Wisconsin this year was the 1939 Engineering Conference in Milwaukee sponsored by the Engineering Society of Wisconsin in cooperation with the Milwaukee Section and the Rock River Valley Section of the A.S.M.E. and others. Held at the Hotel Pfister, the Conference took place March 15–17. Among the various sessions during the three-day meeting were those on mechanical engineering. The first on Wednesday afternoon, presided over by cochairmen R. C. Newhouse and R. C. Glazebrook, featured a paper on "Problems in Steam-Turbine Design," by Hans Dahlstrand, engineer, Allis-Chalmers Mfg. Co., and another on "Diesel Engines," by Julius Kuttner, research engineer, Fairbanks, Morse & Co.

Thursday afternoon was devoted to inspection trips to the factory of the Allis-Chalmers Mfg. Co., the municipal filtration and sewerage plants, power stations, concrete mixing, and products plants. Friday afternoon at the mechanical-engineering session, Werner I. Senger, engineer, Gisholt Machine Co., discussed the "Latest Developments in Balancing Machines," and Robert Harris, engineer, C.M.St.P.&P.R.R., described the methods used in the "Fabrication of the Hiawatha Train."

Junior Group Activities

Philadelphia Junior Group Has Meeting and Plant Trip

THE Junior Group in Philadelphia had a very interesting meeting on Feb. 8. Talks at the meeting were based on boiler feedwater treatment. G. K. Fisher and Richard Hutchinson, Juniors A.S.M.E., and both with the Cochrane Corporation, gave an account of external treatment. Their discussion covered the method of removal of the hard salts and dissolved gases. T. F. Sheen, engineer, W. H. & L. D. Betz Co., presented a paper on internal treatment and illustrated it with practical examples.

An inspection trip was made by the Junior members to the Dodge Steel Company on the evening of Feb. 22. There they were treated to a demonstration of the making of steel castings.

Cleveland Juniors Hear About Automatic Controls

THE Cleveland Junior Group of the A.S.M.E., at a meeting held in the Bingham Building on the campus of the Case School of Applied Science on Feb. 20, heard a very interesting discussion on the "Selection of Automatic Controls for Continuous Processes," by H. H. Gorrie, junior A.S.M.E., and engineer, Bailey Meter Co.

Clearly illustrating with slides the most important points of his topic, Mr. Gorrie covered thoroughly the various types of control equipment used; the different applications to which each is best suited, such as controls for temperature, thermal capacity, pressure, water level, draft pressure, etc.; why one type is used for a particular application in preference to another; and the operating characteristics of each type, which govern the possible degree of regulation, sensitivity, etc.

Tri-Cities Juniors Hear Talk on Resistance-Welding Control

AT the meeting of Feb. 22, held in the People's Power Company, Rock Island, Illinois, 56 members and friends were present.

The meeting was opened by vice-chairman, William Blaser, who turned the meeting over to the previous chairman, Carl Hand. Mr. Hand then introduced J. R. Patterson of the local office of the Square D Company, who in turn introduced the speaker, F. H. Roeby, from the Milwaukee factory of his company.

Mr. Roeby explained that of the four important periods of the welding cycle—first, the squeeze, second, the weld, third, the hold, and fourth, the off-period—his talk would deal with the very important period of the weld time. By means of blackboard sketches, he went into the theory back of the present development of an accurate weld time of a half cycle. By means of the cathode-ray oscillograph, a timer, and a resistance-welding machine, it was demonstrated very clearly that a welding time of half a cycle or any interval up to ten cycles could very readily be obtained by a slight manipulation of the timer, which is operated by a synchronous motor.

Roy V. Wright Talks Before Metropolitan Junior Groups

METROPOLITAN junior members were fortunate in having Roy V. Wright, past-president A.S.M.E., address them on the subject, "The Engineer as a Citizen," at the Feb. 7 meeting in the Engineering Societies Building. Dr. Wright spoke from his experience in both engineering and politics, and pointed out the engineer's responsibility to the community. He showed the necessity for creation of a better social structure through the displacement of the political "old guard" by men of understanding and ability, including the engineer whose technological inventions are blamed by many for some present-day ills.

Air-conditioning seminar meetings of the Metropolitan Junior Group continue in popularity. Their value is also recognized by senior members, who now outnumber the younger members in attendance. Attendance averages between 40 and 50 at each session. The February 14 meeting featured C. H. B. Hotchkiss, editor of *Heating and Ventilating*, on the subject, "Trends and Tendencies of the Heating, Ventilating, and Air-Conditioning Industry." "The Control of Sound in Air Conditioning Systems," was discussed by J. S. Parkinson at the March 7 meeting of the Group. Mr. Parkinson, in charge of acoustical engineering, Johns-Manville Research Laboratories, spoke on the fundamentals of sound and its measurement and control, and contributed a large amount of general information on its causes and effects in air-conditioning systems.

With the Student Branches

A.S.M.E. 1939 Student Group Meetings to Be Held in Ten Cities in March and April

Delegates and Members From 117 Student Branches and Officers of National Society Will Attend

AGAIN the time has arrived for the Student Group Meetings of the 118 Student Branches of the A.S.M.E. Starting on March 20 and extending through the month of April, meetings will be held in ten cities scattered throughout the United States. A complete schedule of the names of the host Student Branches, places, dates, and the representative of the Society's Committee on Relations With Colleges is shown on page 335.

Society Officers at Meetings

The importance of these Student Meetings is shown best by the fact that there will be present at each an officer of the Society. President A. G. Christie will attend the meetings in Ithaca, N. Y., and Knoxville, Tenn. Other officers and the place of the meetings they will attend are as follows: Vice-President L. W. Wallace, Chicago, Ill., and St. Louis, Mo.; Vice-President Alfred Iddles, Princeton, N. J.; Vice-President James W. Parker, Cleveland, Ohio; Council Member Edward W. Burbank, Dallas, Texas; Vice-President W. Lyle Dudley, Corvallis, Ore.; Council Member Frank H. Prouty, Boulder, Colo.; and Vice-President Warren H. McBryde, San Francisco, Calif.

What's in Store for Student Members

Student members who go to the meetings are assured of having a good time if the early plans of some of the host schools are any indication. LEWIS BRANCH will hold the Midwest Group Student Meeting at the Stevens Hotel in Chicago, April 17–18. Technical sessions will be held Monday afternoon and Tuesday morning. The rest of the daytime will be devoted to inspection trips to the Hawthorne plant of the Western Electric Co., International Harvester Company, the Fisk Station of the Commonwealth Edison Co., Goodman Manufacturing Co., Rosenwald Museum of Science and Industry, and the studios of the National Broadcasting Company. The banquet will be held Monday evening at the Stevens. More than $100 in cash and various other valuable prizes will be given to the student members presenting the best papers at the technical sessions.

SOUTHERN METHODIST BRANCH will act as host at the Baker Hotel in Dallas, Texas, to the Student Branches in the Southwest Group, March 20–21. The arrangement of technical sessions, banquet, and inspection trips is practically the same as that for the Chicago meeting with, of course, different papers and different inspection trips. Of particular interest to those attending is the generosity of John W. Carpenter, president of the Texas Power & Light Co., who is treating the boys to luncheon at the Dallas Athletic Club on Monday.

A.S.M.E. STUDENT BRANCH MEMBERS AT DREXEL INSTITUTE OF TECHNOLOGY

CASE BRANCH will do its part for the Alleghanies Group at Cleveland, Ohio, April 30–May 2. Monday and Tuesday mornings will be devoted to technical sessions while the afternoons will be spent in visiting various Cleveland plants. The climax of the Meeting will be the banquet and dance at the Wade Park Manor on Tuesday evening. Monday evening will feature a stag entertainment at the Case Club.

Here and There

Alabama Open House

ALABAMA BRANCH members did their part on Feb. 22 in celebrating "Greater Auburn Day" in recognition of the $1,500,000 building program instituted then. The boys got together with the student members of the A.I.E.E. and held an open house in the engineering laboratories. Visiting alumni and others were conducted through the labs where the machines were run and explained by student members.

About 10 student members of the ARIZONA BRANCH will attend the Pacific Southwest Student Meeting in San Francisco on April 3–4.

ARMOUR INSTITUTE BRANCH hereby warns the other Branches who are attending the Midwest Student Meeting in Chicago, Ill., that it is out to win first prize. To encourage the boys, the faculty has promised an additional reward to the member who gets it.

53 at California Branch Banquet

The spring banquet of the CALIFORNIA BRANCH on Feb. 8 was a big success. Faculty and members, numbering 53, enjoyed a sumptuous feast, entertainment, and an interesting meeting. The entertainment consisted of some songs by Don James who was accompanied by Dan Dalquist. Prof. Ira B. Cross of the economics department gave an extremely interesting résumé of the economic characteristics of the world.

CALIFORNIA TECH BRANCH'S new officers, elected at the meeting of Feb. 10, are William Norton, chairman; Herbert Strong, vice-chairman; Harry O. Davis, secretary; and Robert Spielberger, treasurer.

Sack of Nanking at Case

A lecture on "The Old China and the New" was delivered and the motion picture, "The Sack of Nanking," shown to the members of the CASE BRANCH on Feb. 23 by Dr. James H. Swan, who was a former medical officer in China. On March 8 the annual A.S.M.E. raffle was started to raise money for the coming Alleghanies Student Meeting in Cleveland, April 30–May 2. Price of raffle tickets was 10 cents each.

CATHOLIC BRANCH had as its guest speaker on Feb. 8, H. N. Eaton, member A.S.M.E., and chief of the hydraulic division of the Bureau of Standards. He gave an illustrated talk on hydraulics in which he showed some unusual pictures of the laboratories in Germany and other parts of Europe.

C.C.N.Y. BRANCH held an induction smoker during February. Bridge, chess, music, motion pictures, food, and refreshments were the order of the evening. New members were introduced individually.

New Colorado Machine Shop

COLORADO BRANCH announces with pride the completion of a new machine shop. The old machine shop in the mechanical-engineering building is being converted into two classrooms. Another room in the building will be turned over to the Branch for its headquarters.

Beginning on Feb. 1, COOPER UNION BRANCH was divided into a night division for night students and a day division for day students. The meeting of the day division on Feb. 8 featured Dan Russ in a talk on "The Theory and Design of Hydrometers." At the evening division meeting on Feb. 17, A. Budde, chairman of the group, presented a paper on the theory and application of high-pressure gages in the production of mechanical devices.

CORNELL BRANCH had C. R. Davis present a paper on "The Manufacture of Nuts and Bolts" at the Jan. 10 meeting. On Jan. 24, P. V. Riera gave a talk on "The Preparation of Sulphide Paper," which he illustrated with a motion picture borrowed from the Hammermill Paper Co.

DREXEL BRANCH at its meeting of Feb. 8, had a good crowd to welcome back George K. Marple, superintendent of machinery, New York Shipbuilding Corporation, who spoke to the Branch last year. This time his subject was "Modern Ship Design."

Duke Learns About Neoprene

After citing the disadvantages of rubber for some applications, Russell Smith, engineer, E. I. du Pont de Nemours Co., in a talk presented before the DUKE BRANCH on Feb. 5, told of the discovery of Neoprene and of its many uses in industry today.

FLORIDA BRANCH, in preparation for the Student Meeting in Knoxville, Tenn., April 10–11, has been encouraging members to present papers at meetings of the Branch. On March 3, Pearson described the S.A.E., Stockwell revealed the principles behind the Everel single-bladed airplane propeller, and Wells gave a description of the National Bureau of Standards.

Through the courtesy of the International Harvester Company, ILLINOIS BRANCH was able to show two motion pictures at the meeting of Feb. 22 on the use of Diesel engines in trucks and tractors.

ENGINEERS AT PRATT

(Group intently watching demonstration given by Air-Reduction Sales Corporation, including liquid air, oxyacetylene cutting torch, and oxygen lance.)

JUNIORS AND SOPHOMORES OF A.S.M.E. STUDENT BRANCH AT CASE SCHOOL OF APPLIED SCIENCE

SENIORS OF A.S.M.E. STUDENT BRANCH AT CASE SCHOOL OF APPLIED SCIENCE

At the IOWA BRANCH meeting of Feb. 22, J. Sandoval gave a description of "The Mill on the Hill," and V. Wagner discussed "The Main Idea Behind Ford's Small Rural Plants."

Mearl E. Noftz, student member of IOWA STATE BRANCH gave a very interesting talk at the Feb. 22 meeting on the operation of two types of automotive hydraulic clutches. He developed the dynamic equations involved, explaining in detail each of the various phases of operation.

Kentucky's Trip to Cincinnati

On Feb. 10, 27 members of KENTUCKY BRANCH made a trip to Cincinnati as guests of the CINCINNATI BRANCH. After a tour of the campus and a broadcast over the University's short-wave station W8CYX, the boys had lunch in the student cafeteria. In the afternoon, inspection trips were made to the Cincinnati Milling Machine Company's plant and to the factory of the Cincinnati-Bickford Tool Company. After a banquet in the evening, Morris Martellotti, Cincinnati Milling Machine Company talked on "Problems of Machining Smooth Surfaces," aided by slides and motion pictures. Then the group adjourned to "Schmeizing's" in Norwood for a stag party. A good time was had by all.

More than 525 student members, professors, and visitors were pr sent on Feb. 17 at a meeting of the LEHIGH BRANCH to see the colored motion picture, "Steel—Man's Servant."

LOUISVILLE BRANCH members went to Lexington, Ky., on March 4 to hold a two-day joint meeting with the KENTUCKY BRANCH.

L.S.U. at Spring Meeting

As part of the Spring Meeting of the A.S.M.E. and the annual meeting of the Louisiana Engineering Society, Feb. 23–25, the Student Branches of the A.S.M.E. and the A.S.C.E. at LOUISIANA STATE UNIVERSITY and TULANE UNIVERSITY held a conference on Feb. 24 in the St. Charles Hotel, New Orleans, La. Donald E. Jahncke, A.S.M.E. student member of TULANE BRANCH, talked on "The Social Responsibility of the Engineer." F. J. Richardson, A.S.M.E. student member of L.S.U. BRANCH, described "A New Evaporator System."

"Abrasives, Their Manufacture and Application in the Coated Form" was the topic of a lecture given before 200 members and guests of M.I.T. BRANCH on Feb. 15, by A. Q. Hastings, Behr-Manning Corporation, manufacturers of abrasive paper.

Michigan Occupational Conference

MICHIGAN BRANCH members, together with other students of the University, were given first-hand advice concerning the kind of job seekers business and industry are looking for when the University's Annual Job Conference convened there March 20–25. Personnel experts and business leaders from all parts of the United States were on hand during the six-day conference to give the students information on the personal qualifications and technical training necessary for government and politics, social service, research, plant management, aviation, personnel, sales, education, and advertising. One entire discussion was devoted to "How to Apply for a Job in an Interview."

UNIVERSITY OF FLORIDA STUDENT BRANCH MEMBERS

Papers were presented during February at the weekly meetings of MICHIGAN STATE BRANCH by W. R. Clow, R. C. Clough, Charles Gladden, M. J. Groat, Arnold Johnson, H. S. Keller, Arthur Kerkau, Charles Kilburn, Russell Lloyd, John Macomber, Bernard Maurer, Robert Sterling, and R. S. Trembath.

C. E. Davies at Mississippi

More than 150 student members of MISSISSIPPI STATE BRANCH and faculty men were present at the meeting of Feb. 28 to welcome C. E. Davies, Secretary of the National Society. The subject of his address was "Building a Profession," in which he outlined the mission and work of the E.C.P.D. in bettering the engineering profession.

MONTANA STATE BRANCH on Feb. 2 heard a paper on "Valve Timing in Internal-Combustion Engines," by Tom Murdock, and a paper on "Petroleum Production," by Paul Dana.

NEVADA BRANCH members did their part on Engineers' Day which was held at the University on March 4. Besides the many exhibits which were built and operated by the members, Laking, Frankovich, and Peratis took part in the mucking contest, Tilley, Morehead, and Orr entered the transit contest, and the other members of the Branch competed in the slide-rule and riveting contests.

Aviation at Newark College

The Feb. 20 meeting of the NEWARK BRANCH featured as speaker, Norman Potter, in charge of vocational guidance at the Casey School of Aeronautics at the Newark Airport. He described aviation in the past, present, and the future, all of which was punctuated with stories of his experiences in flying.

William C. Balmanno, secretary of the NEW MEXICO BRANCH, reports that Lee Emil Erlandson, vice-chairman of the Branch, died Feb. 10, 1939. Born on May 2, 1918, Mr. Erlandson had been a student member of the A.S.M.E. since 1936, a member of the University's student senate, Kappa Mu Epsilon, and Sigma Tau, business manager of *The New Mexico Engineer*, and a senior student who would have been graduated in June, 1939.

NEW MEXICO STATE BRANCH is making rapid headway in its membership drive. According to Robert M. Yates, secretary of the Branch, it is expected that all eligible candidates will have joined by March.

N.Y.U. BRANCH (evening division) is sponsoring an All-Engineering Dance at the Hotel Belmont-Plaza on the evening of May 27 in cooperation with the student branches of the A.S.C.E., A.I.E.E., and A.I.Ch.E.

North Carolina Asks Help

At the Engineers' Fair to be held at the University, April 14–15, the NORTH CAROLINA BRANCH is planning to have several exhibits. However, one of the exhibits requires the use of models which the members do not have time to build. Therefore, J. B. Lasley, chairman of the Branch, would appreciate it if some company or A.S.M.E. Student Branch could lend him models, not over one cubic foot in size, of a steam engine, steam turbine, stationary Diesel engine, a refrigerant compressor, and a home-heating boiler. The models do not have to be working models, but should look authentic.

NORTH DAKOTA STATE BRANCH enlivens its meetings by having Arthur Bjerkan conduct a quiz program on engineering abbreviations. This is not only interesting but also instructive.

OHIO STATE BRANCH members learned all about "Books and Hollywood" from Prof. Wilson Dumble, of the English department, at the meeting of Jan. 27.

On Feb. 24, more than 100 members and guests of PENNSYLVANIA BRANCH attended a meeting at which E. Burke Wilford, president of Pennsylvania Aircraft Co., outlined the evolution of aviation and showed motion pictures, and Ralph McClarren, secretary of the aviation Division, Franklin Institute, showed pictures of the Focke helicopter and other German aircraft.

Pratt Branch Demonstration

More than 100 members and guests of PRATT BRANCH attended a demonstration on Feb. 23, which was arranged by the Branch through the help of C. B. Jones, instructor in charge of the forge department. Engineers from the Air-Reduction Sales Corporation put on a two-hour show of welding, flame cutting and hardening, and forming.

W. S. Hanley, member A.S.M.E., and chief engineer, Eli Lilly Co., spoke before the PURDUE BRANCH on Feb. 9 on the "European Situation." Having been in England during the recent crisis, Mr. Hanley was able to illustrate his talk with personal experiences. He also included some very interesting and amazing facts regarding the English taxation system and the power of the Houses of Parliament.

A.S.M.E. STUDENT BRANCH AT UNIVERSITY OF PENNSYLVANIA

Hodgkinson at Rensselaer

Francis Hodgkinson, 1938 *Holley Medalist* of The American Society of Mechanical Engineers, was the guest speaker on Feb. 27 at a meeting of the RENSSELAER POLY BRANCH which was attended by more than 200 members and guests. Mr. Hodgkinson spoke on the problems encountered in building turbines and their solutions with special emphasis on the economics of manufacturing. Prior to the meeting, Charles Culp, general manager of the Rensselaer Central Railroad, which was built by the Branch, announced that stock in the venture could be bought by student members. The railroad, which is now in operation, was described in this section in December, 1938.

TEXAS BRANCH announces the appointment of members to the following committees. Program, J. F. Wilson, chairman, W. R. Woolrich, and J. L. Norman; social, W. A. Lane, chairman, R. L. Fuller, and P. B. Niland; publicity, J. M. Scott, chairman, F. J. Peabody, and E. L. Pace; membership, J. L. Malone, chairman, B. J. Bartels, and J. A. Scanlon.

At the meeting on Feb. 28 of the TEXAS TECH BRANCH, papers were presented by Clovis Green on "Application of Theoretical Laws Relating to Internal-Combustion Engines," L. J. Powers on "High-Speed Indicators," and Henry Meredith on "Boiler Failure Due to Embrittlement."

The Boyds at Toronto

TORONTO BRANCH has a unique combination of Boyds as Branch officers; Winnett Boyd is chairman and Robert N. Boyd is secretary-treasurer. A sample of the programs they put on is evidenced by the meeting of Feb. 21 when P. B. Dilworth, student member, spoke on "The Governing of Oil Engine," and J. W. Jolly, Atlas Polar Company, gave a paper on stationary and marine Diesel engines.

The meeting of Feb. 17 of the VERMONT BRANCH featured talks by B. W. Harriman on the inventions in aviation and by C. A. Renfrew on "Small Business."

VILLANOVA BRANCH had Harte Cooke, vice-president of the A.S.M.E., as guest speaker on Jan. 12. He gave a talk on "Diesel Engines."

VIRGINIA BRANCH had as guest speaker on

AT JOINT MEETING OF A.S.M.E. STUDENT BRANCHES OF UNIVERSITY OF LOUISVILLE AND UNIVERSITY OF KENTUCKY AT LEXINGTON, KY., MARCH 4, 1939

MEMBERS OF UNIVERSITY OF KENTUCKY STUDENT BRANCH ON A RECENT VISIT TO CINCINNATI WHERE THEY WERE GUESTS OF UNIVERSITY OF CINCINNATI STUDENT BRANCH
(Photograph was taken by "Spot" Evans.)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
1939 STUDENT MEETINGS

	Group	*Host Student Branch*	*Place*	*Dates*	*Representative of Committee on Relations With Colleges*
I	New England*	Cornell University	Ithaca, N. Y.	April 14–15	A. C. Chick
II	Eastern	Princeton University	Princeton, N. J.	April 24–25	F. V. Larkin
III	Alleghenies	Case School of Applied Science	Cleveland, O.	April 30–May 2	F. V. Larkin
IV	Southern*	University of Tennessee	Knoxville, Tenn.	April 10–11	E. W. O'Brien
V	Midwest	Lewis Institute	Chicago, Ill.	April 17–18	J. D. Cunningham
VI	North Central	Missouri School of Mines & Metallurgy	St. Louis, Mo.	April 20–21	H. O. Croft
VII	Southwest	Southern Methodist University	Dallas, Texas	March 20–21	H. E. Degler
VIII	Pacific Northwest	Oregon State College	Corvallis, Ore.	April 3–4	E. O. Eastwood
IX	Rocky Mountain	University of Colorado	Boulder, Colo.	April 20–21	F. H. Prouty
X	Pacific Southwest	University of Nevada and University of Santa Clara	San Francisco, Cal.	April 3–4	G. L. Sullivan

* President A. G. Chrisitie will attend these meetings.

Feb. 3, Maxwell C. Maxwell, who gave a talk on "Loxology."

Washington Student Speakers

During February, papers were presented by the following student members of the WASHINGTON BRANCH: Paul Sherwood, Otis Lampson, James Robertson, George Martinson, John Messer, J. D. Ross, Donald Ross, and Philip Conkle. At the dinner meeting on Feb. 28, after a vote by the members, Sherwood, Lampson, and Robertson were selected in that order for the presentation of the best papers.

LAST CALL!!!

All reports and photographs from Student Branches for insertion in the May issue of MECHANICAL ENGINEERING, which is the last copy to be received by student members for the school year 1938–1939, must be received at A.S.M.E. Headquarters not later than April 6. Anything received after that date cannot be used.

News of the A.S.M.E. Woman's Auxiliary

THE MARCH meeting of the Woman's Auxiliary was held on the afternoon of March 9 in the assembly room of the new building of the Electrical Testing Laboratories. In the absence of our president, Mrs. Farny, Mrs. E. C. Stahl, the second vice-president presided. Dr. Preston G. Millar, President of the Laboratories greeted the group and told of the different products of particular interest to women which are tested in the Laboratories—even cosmetics.

The reports of the Student Loan Fund were most gratifying. New York reported that five students had made payments on their loans; Philadelphia reported that its first benefit for their loan fund was extremely successful and $94.50 was raised; Cleveland that the first payment was made to their first student, who is attending Case School of Applied Science, and their plans for augmenting their fund; Baltimore that there are active plans for their fund.

On April 13 at the Engineering Woman's Club in New York the first yearly benefit for the Student Loan Fund will be given in the afternoon, 2 p.m. Since many members do not play cards, the committee felt they would enjoy a demonstration given by the International Silk Guild. Panels of different types of silk fabrics will be shown and there will be an interesting contest to determine which panels contain the five different fibers. A small fee of fifty cents is being charged, and it is hoped that the attendance will reach a hundred.

Attendance will enable every member to contribute her share to the fund and as no tickets will be sent to the membership, those desiring extra tickets for guests may communicate with Mrs. F. M. Gibson, Eton Hall, Kew Gardens, L. I. This is the occasion for those who do not play cards to rally to the support of the Student Loan Fund.

The Auxiliary is indebted to Mr. and Mrs. F. M. Farmer for a charming and hospitable Tea given after the tour of the Laboratories under capable and courteous guidance.

BURTIE HAAR,
Chairman, Publicity Committee

Four Sessions at Applied Mechanics Meeting, June 14–15

AT AN executive committee meeting of the Applied Mechanics Division at M.I.T. on Feb. 24, plans for the national meeting of the Division at Columbia University, June 14–15, were discussed. According to R. Eksergian, chairman of the Division, the program will contain four sessions, one each on elasticity and strength of materials, in charge of R. E. Peterson; lubrication, in charge of F. B. Karelitz; plasticity, in charge of A. Nádai; and dynamics and fluid mechanics, in charge of J. Ormondroyd. Anyone desiring to present a paper must communicate immediately with R. Eksergian, Edw. G. Budd Mfg. Co., 25th St. and Hunting Park Ave., Philadelphia, Pa.

Petroleum Division Plans to Question Members on Subject Interests

AT A meeting of the Atlantic Coast Group of the Petroleum Division on Feb. 28, it was decided to circularize the members registered in the Division to ascertain their active interest in such phases of the subject as producing, refining, transportation, and marketing, and to secure suggestions for interesting programs at local and national meetings. Any member not registered in the Division may secure the questionnaire by writing to A.S.M.E. headquarters.

Warner Seely on Executive Committee of Machine Shop Practice Division

THE NEW member on the Executive Committee of the Machine Shop Practice Division is Warner Seely, Warner & Swasey Co., Cleveland, Ohio. Other members of the Executive Committee are A. M. Johnson, chairman, Erik Oberg, B. G. Tang, and J. R. Weaver. W. A. Johnson, junior A.S.M.E., is staff secretary. The Division is contemplating participation in the Machine Tool Congress at Cleveland, Ohio, in October, 1939.

Greenville Section Plans National Textile Meeting

The National Textile Meeting of the A.S.M.E. will be held under the joint sponsorship of the Greenville Section and the Textile Division in Greenville, S. C., on April 5, in connection with the Textile Exposition. The program for the meeting will consist of papers in the morning on "Flax—Its Possibilities in a Cotton Mill," by C. G. Worthington; "New Mechanical Ideas and the Textile Engineer," by F. V. Naughton; "Fluorescent Lighting," by a General Electric engineer; and a subject, not yet selected, by a student member from Clemson College. In the afternoon, members will be able to visit the Textile Exposition. In the evening, a banquet will be held at the Poinsett Hotel with Eugene W. O'Brien, past vice-president of the Society as speaker.

G. E. Hagemann, Chairman of Materials Handling Division

PRESS of business made it necessary for R. B. Renner to relinquish the chairmanship of the Materials Handling Division. At the meeting of the Division on Feb. 14, G. E. Hagemann, Alexander Hamilton Institute, New York City, was elected to fill the vacant office.

A.S.M.E. Members May Join Professional Divisions

ALL members of the A.S.M.E., particularly Juniors, have the privilege of joining one or more of the 16 Professional Divisions and one Professional Group of the Society at any time. If a member is registered already, he may change if he so desires. Complete information on this phase of Society membership will be found on the inside back cover of the March, 1939, issue of the *Journal of Applied Mechanics*.

Index to A.S.T.M. Standards Available to A.S.M E. Members

THE latest edition of the Index to A.S.T.M. Standards and Tentative Standards, giving information on all standards as of Jan. 1, 1939, has just been issued. The Index is of service to anyone wishing to ascertain whether the Society has issued standard specifications, test methods, or definitions covering a particular engineering material or subject, and is of help in locating the standards in the volumes wherein they appear. Copies of this publication may be obtained by A.S.M.E. members, without charge, on written request to A.S.T.M. Headquarters, 260 S. Broad Street, Philadelphia, Pa.

A.S.M.E. Represented on Newly Formed Corrosion Committee

A NUMBER of technical societies and other organizations engaged in the study of corrosion have joined in forming the American Coordinating Committee on Corrosion, which is to serve as a clearing house and coordinating agency for information on experience and work in progress in the field of corrosion and corrosion prevention. The Committee was formally organized on Feb. 17, 1939, at a meeting held at the headquarters of the American Society for Testing Materials at Philadelphia. Among the 18 cooperating organizations is The American Society of Mechanical Engineers, which is

represented by S. Logan Kerr, member A.S.M.E., and C. H. Fellows, member A.S.M.E., as alternate.

As its first step the Committee is compiling a list of the names and addresses of those working in the field of corrosion in this country, together with information as to their special interests and their current programs of corrosion studies. However, it is not the purpose of the Committee to abstract the literature on corrosion.

The next meeting of the Committee will be held in June at Atlantic City, N. J., during the A.S.T.M. annual meeting, at which the information thus far compiled will be reviewed. A permanent organization will be effected at that time, and the work of the Committee further considered.

Management Courses to Be Held at University of Iowa in Summer

COURSES in management will be held this summer at the University of Iowa. A special three-week course for people in industry will be held from June 12 to June 30, and an eight-week course for college and university instructors, and for undergraduate and graduate students from June 12 to Aug. 4. These courses are intended for people interested in comprehensive training in motion and time study, waste elimination, cost reduction, plant layout, and related subjects. Further information may be obtained from Prof. Ralph M. Barnes, State University of Iowa, Iowa City, Iowa.

The American Council of Commerical Laboratories Formed

SEVERAL research and testing laboratories of the country have formed the American Council of Commercial Laboratories to maintain testing, research, inspection, and the laboratory art as a whole upon a high plane and to conduct their operations in such a manner as to insure competency and reliability in whatever they may undertake. The president of the new organization is Preston S. Millar, of New York, and the secretary is D. E. Douty, 1415 Park Avenue, Hoboken, N. J. James H. Herron, past-president of the A.S.M.E., is one of the members of the executive committee.

Foundrymen to Meet in Cincinnati, May 15–18

THE 43rd annual convention of the American Foundrymen's Association will be held in Cincinnati, Ohio, May 15–18. Further information may be obtained from the Association at 222 W. Adams St., Chicago, Ill. Plans are now being made by the Association to participate in the World Foundry Congress, which will be held this year in London, June 12–17, under the auspices of The Institute of British Foundrymen.

Midwest Power Conference Chicago, Ill., April 5–7

UNDER the sponsorship of Armour Institute of Technology in cooperation with Iowa State College, Michigan State College, Purdue University, State University of Iowa, University of Illinois, University of Michigan, University of Wisconsin, and local engineering groups, including the Chicago Section of the A.S.M.E., the Midwest Power Conference will be held at the Palmer House, Chicago, Ill., April 5–7. The purpose of the Conference is to offer all persons interested in power production an opportunity to meet together for the study of mutual problems. Conference director is Dean L. E. Grinter, Armour Institute of Technology, 3300 Federal St., Chicago, Ill.

The sessions include papers by L. W. Wallace, vice-president A.S.M.E., on "The Achievements of Research in Power;" by Alex D. Bailey, past vice-president A.S.M.E., on "Developments in Central Station Power Plants;" by L. H. Morrison, member A.S.M.E., on "The Social Significance of the Development of Diesel Power;" by C. G. A. Rosen, member A.S.M.E., on "Diesel Tractor Power;" by R. V. Kleinschmidt, member A.S.M.E., on "Reducing Pollution of Air by Power Plants;" and by G. C. Daniels, member A.S.M.E., on "Power Plant Auxiliaries."

H. O. Croft Elected President of Iowa Engineering Society

HUBER O. CROFT, member A.S.M.E., and head of the department of mechanical engineering at the University of Iowa, Iowa City, Iowa, was elected president of the Iowa Engineering Society at the annual convention in Des Moines, Feb. 17. Professor Croft is well known for his work in the A.S.M.E. as a member of the Committee on Relations With Colleges, and of the Power Test Code Committee No. 21, and as chairman of the program committee of the Fuels Division. He is also a member of the Committee on Student Selection of the E.C.P.D.

Gear Manufacturers Meet at Virginia Beach, May 22–24

THE annual meeting of the American Gear Manufacturers Association will be held at the Cavalier Hotel, Virginia Beach, Va., May 22–24. Among the papers to be presented are those on modern drafting-room practice, surface hardening of gear teeth, turret lathes in a gear shop, gear metallurgy, and bronze for work gears. Additional information may be obtained from J. R. McQuiston, 602 Shields Building, Wilkinsburg, Pa.

A.S.H.V.E. to Meet at Mackinac Island, July 4–6

THE semi-annual meeting of the American Society of Heating and Ventilating Engineers will be held this year at Mackinac Island, Michigan, July 4–6. The Michigan chapter of Detroit and the Western Michigan chapter will act as hosts. Further information may be obtained from the Society, 51 Madison Avenue, New York City.

A.I.E.E. Awards Lamme Medal to Marion A. Savage

THE 1938 LAMME MEDAL of the American Institute of Electrical Engineers has been awarded to Marion A. Savage, designing engineer, General Electric Co., "for able and original work in the development and improvement of mechanical construction and the efficiency of large high-speed turbine alternators." Presentation will be at the summer convention of the Institute, in June, at San Francisco.

Professional Engineer Defined

AT THE request of the Ohio State Board of Registration for Professional Engineers and Surveyors, the Attorney-General of Ohio, John W. Briker, rendered the following opinion relative to the illegal use of the term "engineer" as used in various telephone directories by men who are not licensed to practice engineering in the State of Ohio: "Under the provisions of Section 1083-1, et seq., General Code, a person who has not been duly licensed as a registered professional engineer may not advertise in the state of Ohio that he is a civil engineer or make use of some other similar title."

Food Preservation Conference at Austin, Texas, April 13–14

UNDER the auspices of the University of Texas, Austin, Texas, with the cooperation of the American Society of Refrigerating Engineers, the A.&M. Engineering College of Texas, and the Southwestern Ice Manufacturers Association, the third annual Food Preservation Conference will take place on April 13 and 14. Chairman of the Conference is Byron E. Short, member A.S.M.E., and professor of mechanical engineering at the University.

Californians, Inc.

THE OCEAN BEACH, SAN FRANCISCO

(A.S.M.E. Semi-Annual Meeting will be held in San Francisco, July 10–15. See page 328.)

American Engineering Council

Presents

The News From Washington and Elsewhere

Bills in Congress of Interest to Engineers

AMONG the bills introduced in the present session of the Congress of the United States are the following bills: H.R. 3652 by Representative Lea proposes to promote industry and commerce through research in the physical sciences, referred to Committee on Interstate and Foreign Commerce; H.R. 4500 by Representative Green supplements the Act approved Mar. 2, 1887, by aiding and promoting research in the engineering experiment stations of the colleges established and designated in the several states under the provisions of the Act approved July 2, 1862, and the Acts supplemental thereto, referred to Committee on Agriculture; and H.R. 4589 by Representative Jones of Texas authorizes the encouragement of engineering research at experiment stations, referred to Committee on Agriculture.

A.E.C. Represented on Federal Map Board

Prof. John S. Dodds, chairman of the A.E.C. Committee on Surveys and Maps, has been appointed by President William McClellan of the Council with the approval of the A.E.C. Executive Committee, as a member of the Advisory Council of the Federal Board of Surveys and Maps.

To further a program of mapping, a letter has been mailed to all the secretaries of member organizations of Council, asking them to make reports expressing the needs of their societies for maps, and submit such reports to the Federal Board of Surveys and Maps, with copies to Professor Dodds and the executive secretary of the A.E.C.

Californians, Inc.

MISSION DOLORES, ESTABLISHED IN 1776, SAN FRANCISCO'S MOST HISTORIC SHRINE

(A.S.M.E. Semi-Annual Meeting will be held in San Francisco, July 10–15. See page 328.)

Representatives of A.E.C. to Attend Philadelphia Meeting

The American Academy of Political and Social Science has requested the A.E.C. to be represented at its annual meeting in Philadelphia on March 31 and April 1. William McClellan, member A.S.M.E., William L. Batt, past-president A.S.M.E., and Frederick W. Feiker, member A.S.M.E., have been appointed delegates of the Council to the meeting.

A.E.C. Sends Information to League of Nations

At the request of the International Institute of Intellectual Cooperation, which is an affiliate of the League of Nations, the Engineering-Economics Committee of the A.E.C. has been cooperating in forwarding to that organization publications of member organizations, including the A.S.M.E., which have to do especially with the problem of mechanization and its relation to employment.

Ernest Hartford, Chairman of 1940 Secretaries' Conference

Ernest Hartford, Assistant Secretary of the A.S.M.E., has been chosen chairman of the 1940 Engineering Societies Secretaries' Conference, held concurrently with the annual meeting of the A.E.C. in Washington, D. C. Looking forward to this conference, Mr. Hartford has addressed a letter to the secretaries of 96 engineering societies in this country calling the meeting to their attention and urging that arrangements be made now for their attendance. He adds in the letter the fact that from time to time additional information will be sent to each secretary with regard to the forthcoming conference.

A.E.C. Discusses Problem of Government Reorganization

Engineers have a double interest in the question of reorganization of the Federal Government. They recognize the eventual necessity of a balanced-budget viewpoint in the Federal Government and secondly, they believe that government expenditures for public works could best be managed from a policy and efficiency point of view if the various agencies which concern themselves with the many divisions and sections of public works were brought together under one administrative head.

During the several A.E.C. Forum discussions on employment, on invention, on government planning, and on government reorganization, three fundamental principles have emerged which, while they were not expressed as an official platform for engineers, nevertheless may be said to represent the majority opinion of the groups discussing the four topics. These conclusions may be put briefly as: (1) The need of a clearer government fiscal policy; (2) the hope for more efficient management by coordination and consolidation of present agencies into a simplified and responsible administrative organization of the government; (3) the need of divorcing administrative personnel from politics and the establishment of engineering professional and management services in the government on the merit system under nonpartisan civil-service guidance.

As this summary is being written three bills on Federal reorganization are before the Federal Congress. The first is the Byrnes Bill (S. 1265) which associates public works, either as a department or a division, with social security and is an attempt to merge the PWA and the WPA into some sort of a public-works department. The second is the so-called Cochran Bill (H.R. 4425) which gives the President power to reorganize the government with the approval of Congress. This essentially is the bill which failed of passage last year because of controversial elements, most of which have been removed in the new bill. A third bill, introduced by Senator Byrd (S. 1706), provides for Presidential reorganization of government departments, eliminates the six Presidential assistants, and compels Congressional vote on proposals within twenty days.

By far the most interesting contribution to this discussion is the factual report released by the Brookings Institution in a 275-page volume. The gist of this report is that the possibilities of economy through structural reorganization of federal administrative agencies are relatively minor in comparison with those which might be realized by the elimination and curtailment of activities. A digest of the Brookings report, which presents facts having a direct bearing on the questions of government economy and its interrelation to government reorganization, has been prepared for A.E.C.

Local Sections

Coming Meetings

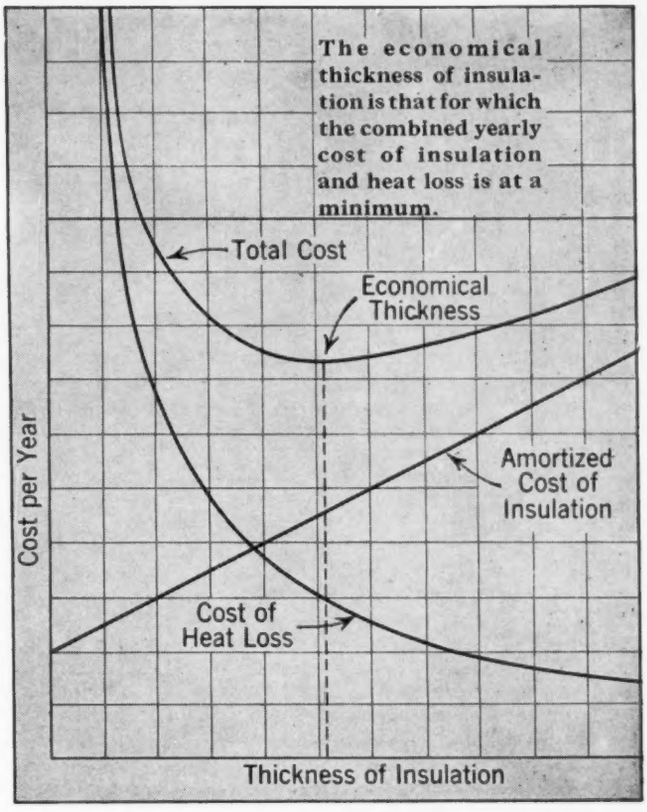
Anthracite-Lehigh Valley: April 28. Lafayette College, Easton, Pa., at 8:00 p.m. Subject: "The Application of Hydraulic Mechanisms to Machine Tools," by C. C. Stevens, mechanical superintendent, New Departure Division, General Motors Corporation, Bristol, Conn.

Baltimore: April. To be held at Engineers Club. Talk on "Refrigeration Machinery." Plan to designate this "Student Night."

Central Pennsylvania: April 20. Campus, The Pennsylvania State College at 7:45 p.m. Subject: "Recent Developments in Aero-

(*A.S.M.E. News continued on page 340*)

How to SAVE THE MOST MONEY with INSULATION


The economical thickness of insulation is that for which the combined yearly cost of insulation and heat loss is at a minimum.
Total Cost
Economical Thickness
Amortized Cost of Insulation
Cost of Heat Loss
Cost per Year
Thickness of Insulation

Make sure all your equipment is insulated with the *correct materials* in the *one correct thickness* that combines maximum operation efficiency with minimum heat waste

WHETHER or not your insulation is a paying investment depends entirely on the materials used and the amount applied. *Too much* will never pay an adequate return . . . *too little* results in heat losses that build up excessive fuel bills. But proper insulation, properly applied, will avoid both these costly mistakes. And a J-M Engineer will be glad to work out the most economical application.

Let him go through your plant and make a thorough study of your requirements. He'll give you the benefits of all the knowledge and data that Johns-Manville has accumulated during 81 years of research and practical experience on insulation problems. He can show you—from the complete line of J-M Insulations in brick, block and pipe-covering form—what materials are best suited for all your equipment. He can tell exactly how much insulation you can profitably use, and his recommendations will point the way to worth-while reductions in your fuel costs.

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For every temperature . . .
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Reduce Your Fuel Costs in 1939

nautics," by Jerome C. Hunsaker, Massachusetts Institute of Technology.

Chicago: April 5–7. Participation in the Midwest Power Conference. Headquarters: Palmer House, Chicago, Ill. (See program in detail on page 337 of this issue.)

Cleveland: April 3. Case School of Applied Science at 8:00 p.m. Dinner at 6:30 p.m. Subject: "Back to College," by senior students in mechanical engineering department.

Erie: April 19. Penn Brass & Copper Co., New Powell Avenue Plant, Erie, Pa. Subject: "Copper Tubes & Products," by Alvin Merrill, American Brass Co. This meeting will be in the form of an inspection trip at the new plant of the Penn Brass & Copper Co., and will be preceded by a motion picture showing the mining, refining, and manufacture of copper into finished products.

Ithaca: April 28. Cornell University in the evening. Subject: "Observations Made Out West," by Prof. F. G. Switzer, of Cornell.

April 29. Trip to Dresden Associated Gas & Electric Generating Station to be followed by a joint dinner meeting with the Rochester Section at Geneva, N. Y., at which E. M. Gilbert of the E. M. Gilbert Corporation of Reading, Pa., plant designer, will speak.

Metropolitan: April 20. Hotel Astor, New York, N. Y. Technical Sessions, 2:00 to 7:00 p.m. Cocktail hour 6:00 to 7:00 p.m. Dinner at 7:00 p.m. President's address 8:30 p.m. Entertainment at 9:00 p.m. Tickets are $3.75. For reservations, table arrangements, and tickets address: C. K. Holland, A.S.M.E., 29 West 39th St., N. Y. C.

Tri-Cities: April 4. Annual all-day inspection trip through Tri-Cities industries.

A.S.M.E. Calendar

of Coming Meetings

April 5, 1939
Textile Meeting
Greenville, S. C.

June 14–15, 1939
Applied Mechanics Division
New York, N. Y.

June 19–22, 1939
Oil and Gas Power Division
Ann Arbor, Mich.

July 10–15, 1939
Semi-Annual Meeting
San Francisco, Calif.

September 4–8, 1939
Fall Meeting
New York, N. Y.

October 5–7, 1939
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Columbus, Ohio

October, 1939
Wood Industries Division
Boston, Mass.

December 4–8, 1939
Annual Meeting
New York-Philadelphia

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

GRADUATE MECHANICAL-INDUSTRIAL ENGINEER, 37, married. Fourteen years' experience including production control, time study, cost reduction, personnel, purchasing, testing, power-plant operation, factory management, and maintenance. Light chemicals and textiles. East preferred. Me-255.

TEACHER of machine design, kinematics, mechanics. Ten years' experience in design, research, and manufacture of machinery; 9 years' teaching. Me-256.

MECHANICAL ENGINEER, 27, married. Experienced in Diesel-engine design and dynamometer tests. Now employed as industrial lubrication engineer with major oil company. Prefers engineering position in internal-combustion engine field. Me-257.

PROFESSIONAL ENGINEER, mechanical; licensed in New York and New Jersey; 14 years' plant-layout and machine-design experience. Would like chemical-plant layout work. Me-258.

FOR SALE: One graduate mechanical engineer, 1938 model, practically unused, excellent condition. Desires purchase by steam-power or machine-tool concern, location immaterial. Good personality. Proved above-average ability. Me-259.

MECHANICAL ENGINEER, 23. Two years' experience designing and estimating in structural and sheet-metal parts; also experience in fuel consumption and heating problems of small units. Me-260.

MECHANICAL ENGINEER, Harvard, age 25, single, seeks position in development, design, or research; 4 years' experience including sales engineering, blowers for industrial process work, heating, and ventilating. Now self-employed. Me-261.

MECHANICAL ENGINEER, 27, single, M.E. Stevens Institute, 1933. Five and one-half years' field and office experience in geodetic survey work (levels, angles, computation, including least-squares adjustment). Advanced mathematical, statistical work. Me-262.

MECHANICAL ENGINEER, 23, B.S. and M.S., Stevens. Two years' experience as production inspector, machinist, draftsman. Specialized in machine design, heating, ventilating, and internal-combustion-engine research. Position with engineering future desired. Me-263.

RESEARCH EXECUTIVE AND EDUCATOR, 41, married. Thorough, practical factory training, and control. Experienced mechanical-engineering designer. Vibration, optics, and associate professor, physics. Harvard, M.I.T., doctorate, honors. Conservative American. Me-264.

MECHANICAL ENGINEER, married, inventive mind; 4 years' experience agriculture-machinery design, testing, drafting, and shop practice; western farm experience; member Tau Beta Pi; now employed. West or Middle West preferred. Me-265.

[1] All men listed hold some form of A.S.M.E. membership.

INSTRUCTOR IN ENGINEERING, 30, single, B.S. in M.E., M.S. in mathematics, registered engineer. Broad industrial experience; taught design and heat-power courses. Opportunity for graduate work desired. Me-266.

REGISTERED ENGINEER desires research or instructorship. A.B., M.E., Stanford, research thesis, heat transfer; Sigma Xi; employed; 26; photographer. Experience: oil-burner research, refinery combustion, pumps, testing, designing air-conditioning equipment. Me-267.

PURCHASING AGENT, graduate mechanical engineer; experienced buyer, familiar with heavy construction materials, building equipment, repair parts, building and mill supplies, commissary items, chemical- and industrial-plant machinery and equipment. Me-268.

MECHANICAL ENGINEER, 26; single; graduate U.N.M.; topographer U.S.F.S.; auto mechanic. Interests: steam and Diesel power operation, heating, air conditioning. Fair knowledge of Spanish. Available June 10, 1939. Me-269-392-D-5-San Francisco.

MECHANICAL GRADUATE, 26, two years' small-plant production and development experience seeking change to development and design. Natural interests and abilities prompt change. Hard and congenial worker. Me-270.

POSITIONS AVAILABLE

GRADUATE MECHANICAL ENGINEER, 35–45, with at least five years' experience as works manager of metal-working plant having as part of its processes metal stamping, deep drawing, and polishing. Experience in pressed-metal field essential. Experience in nonferrous foundry work also desirable. Applicant must show successful record of accomplishment as works manager of company now in good standing, and must be employed at present. Salary, $7500–$10,000 a year. Location, New England. Y-3608.

DESIGNERS with considerable experience in general refinery design, and, if possible, experience along lines of still or furnace construction, or piping. Salary, $250 a month. Location, South, Y-3682C.

GRADUATE ENGINEER with 10 to 15 years' experience in industrial power-plant design and other plant-layout work in the processing or chemical industries. Salary, $3600–$4200 a year. Location, New York, N. Y. Y-3909.

PRODUCTION SUPERINTENDENT, 35–40, with steel-mill experience in heavy forgings and hot metal-working processes. Electric-welding experience would also be desirable. Location, Pennsylvania. Y-3917.

GRADUATE MECHANICAL ENGINEER, 25–26, with training in management problems and two or three years' experience. Position will entail time-and-routine studies, studies of mechanical equipment, equipment layouts, delivery dates, schedules and waste factors, and the writing of reports, recommendations, pro-

(*A.S.M.E. News continued on page 342*)

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cedures, and instructions. Apply by letter giving full details of experience, etc. Man now working in Middle West preferred. Y-3934C.

SALES ENGINEER, 30–45, with three to five years' experience in selling V-belting to industries and distributors. This experience is absolutely essential. Salary, $4000–$5000 a year. Location, New York, N. Y. Y-3936.

GRADUATE MECHANICAL ENGINEER familiar with small rotating machine design and experienced in applications of sleeve and anti-friction bearings. Some of the work will be in connection with complex vibration problems; also, a few of the problems involved are those which have to do with centrifugal governors for small high-speed machines. Location, East. Y-3940.

GRADUATE ENGINEER, about 35, with good technical background in physics and optics and about six or more years' experience in production-engineering work. Must have originality and ability to receive and convey ideas to and from others. Location, New York State. Y-3941.

DESIGNER, graduate mechanical engineer, 28–32, with experience in design of heavy machinery. Some experience in machine shop, foundry, and structural steel desirable. Salary, $250 a month. Location, Pennsylvania. Y-3948.

RESEARCH ENGINEER to act as assistant to director of research of laboratory. Must have research experience and some executive experience, either in directing research or otherwise. Experience in heating and air-conditioning desirable, but is not essential. Location, Pennsylvania. Y-3952.

MECHANICAL ENGINEER, 30–40, for production and maintenance work. Company manufactures paints, varnishes, and printing inks. Experience along these lines essential. Salary, $50–$60 a week. New York, N. Y. Y-3958.

DRAFTSMAN with knowledge of general machine-shop practice as applied to the making of good shop drawings. Must be able to work out original designs, and have good ground work in engineering fundamentals. Experience in printing-press field helpful. Location, New York State. Y-3976.

MECHANICAL ENGINEER, 27–35, who has been graduated within last five years from recognized university with degree of B.S.M.E. Should be capable of making engineering investigation of manufacturing methods, of redesigning present equipment and recommending new equipment to improve present manufacturing methods. Experience with companies manufacturing seamless copper tubing and brass rod desirable but not essential. Location, Middle West. Y-3978C.

COMBUSTION ENGINEERS, three, graduate mechanical engineers for sales and service work in connection with sales promotion of coal. Must have experience in efficient operation of power plants, and be capable of adjusting operating difficulties in client plants. One man for Minneapolis, Minn., one for Chicago, Ill., and one for Pittsburgh, Pa. Must be acquainted with power-plant engineers in assigned territories. Y-3987C.

ASSISTANT CHIEF ENGINEER, 30–40, graduate mechanical engineer with engineering and executive experience, including supervising of men doing engineering work. Must have fair knowledge of business and finance, and be capable and willing to assume responsibilities. Should have knowledge of principles of construction and operation of machinery such as hydraulic pumps, broaching machines, tools, etc. Location, New England. Y-3991.

MECHANICAL OR MINING ENGINEER, 30–35, graduate of recognized engineering school. Must have stood well up in classes, and must have had at least three or four years' practical experience in metallurgical or ore-dressing plant design. Should be thoroughly familiar with ore-dressing operations, and should have specialized in plant-layout and equipment design. Company prefers mechanical engineer who has specialized in ore-dressing plant design with knowledge of machinery installation and plant operation. Location South. Y-4004.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after April 25, 1939, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

BAILIE, BERTRAM L., Peoria, Ill.
BOARDMAN, H. C., Chicago, Ill.
BROWN, NEIL H., London, England
COOPER, K. K., Ft. Wayne, Ind.
ECKLUND, CHARLES, Bridgeport, Conn.
GUCKELBERGER, GEO. W., Forty Fort, Pa. (Rt)
HAERING, DAVID W., Chicago, Ill.
HANDA, J. R., Moghalpura, India
HARRIS, G. S., Baltimore, Md.
HAYWOOD, JOSEPH, Ambler, Pa.
HOELL, GEO. S., Philadelphia, Pa. (Rt)
JEFFERS, FREDK. J., New York, N. Y.
KINGMAN, WM. K., Metuchen, N. J.
LEWIS, LIBBUS, Pittsburgh, Pa.
LINVILLE, THOMAS M., Schenectady, N. Y.
LOTZ, LEONARD C., Newark, N. J.
MARRINER, JOHN M. S., Toronto, Ont., Can.
MARTINSON, GRANVILLE G., Chester, Pa.
MCCANN, JOHN FRANCIS, Longmeadow, Mass. (Rt & T)
MELAN, HERBERT, Berlin, Germany
NEBLETT, ROBERT S., Schenectady, N. Y.
PERAZICH, GEORGE, Philadelphia, Pa.
RAYMOND, LEONARD, Bayonne, N. J.
REEVE, DAVID D., Ontario, Canada
RENTON, VINAL S., Plainfield, N. J.
REPASS, FRANK M., JR., New York, N. Y. (Re)
SANNS, N. J., Ridgefield, N. J.
SCOTT, EDWIN M., Sierra Madre, Calif. (Rt)
SENNER, ARTHUR H., Baltimore, Md. (Re)
SMITH, E. W. P., Cleveland Heights, Ohio
TANAKA, JOSEPH K., New York, N. Y. (Re)
TAVERA (REYES) JESUS, Mexico City, D. F.
TILGHMAN, RICHARD H., East Orange, N. J. (Rt & T)
TINGEY, RICHARD HUME, Quincy, Mass.

CHANGE OF GRADING

Transfer to Fellow

FUNK, N. E., Philadelphia, Pa.

Transfer to Member

BOWKER, HENRY J., Chicago, Ill.
GIORDANO, JOS., Philadelphia, Pa.
PRASS, HERMAN, Brooklyn, N. Y.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

DEWSON, EDWARD H., February 9, 1939
DIEMER, HUGO, March 3, 1939
EARLE, RALPH, February 13, 1939
PARISH, WILLIAM F., March 7, 1939
SOUTHERN, HERBERT, January 27, 1939
WALKER, LEE EARL, December 17, 1938
WILDIN, GEORGE W., February 28, 1939

A.S.M.E. Transactions for March, 1939

THE March, 1939, issue of the Transactions of the A.S.M.E., which is the *Journal of Applied Mechanics*, contains the following papers:

TECHNICAL PAPERS

Methods of Rotor-Unbalance Determination, by J. G. Baker
Tables of Moments and Deflections for a Rectangular Plate Fixed on All Edges and Carrying a Uniformly Distributed Load, by T. H. Evans
Friction Coefficients for the Compressible Flow of Steam, by J. H. Keenan
The Determination of the Expansion Forces in Piping by Model Test, by H. W. Semar
Analysis of Effect of Wire Curvature on Allowable Stresses in Helical Springs, by A. M. Wahl

DISCUSSION

On previously published papers by C. B. Campbell; L. H. Donnell, E. L. Shaw, and W. C. Potthoff; W. M. Dudley; and W. M. Murray

BOOK REVIEWS